L Number	Hits	Search Text	DB	Time stamp
1	252	((non-motorized adj vehicle) (motor adj vehicle)) and ((overl$4 or superimpos$3) with display)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:35
2	46	((non-motorized adj vehicle) (motor adj vehicle)) with ((overl$4 or superimpos$3) with display)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:24
5	46	((non-motorized near2 vehicle) (motor near2 vehicle)) with ((overl$4 or superimpos$3) with display)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:25
6	76	((non-motorized near2 vehicle) (motor near2 vehicle)) same ((overl$4 or superimpos$3) same display)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:32
8	2	((non-motorized near2 vehicle) (motor near2 vehicle)) same ((overl$4 or superimpos$3) same (display with lane$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:36
9	2	((non-motorized adj vehicle) (motor adj vehicle)) and ((overl$4 or superimpos$3) with (display with lane$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:36
11	14	((non-motorized adj vehicle) (motor adj vehicle)) and ((overl$4 or superimpos$3) with (display with line$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:36
10	7	((non-motorized near2 vehicle) (motor near2 vehicle)) same ((overl$4 or superimpos$3) same (display with line$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:42
13	0	((non-motorized near2 vehicle) (motor near2 vehicle)) same ((overl$4 or superimpos$3) same (display with road adj2 line$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:42
14	0	((non-motorized near2 vehicle) (motor near2 vehicle)) and ((overl$4 or superimpos$3) same (display with road adj2 line$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:42
15	0	((non-motorized near2 vehicle) (motor near2 vehicle)) and ((overl$4 or superimpos$3) same (display with road adj2 lane$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 07:20
16	0	((overl$4 or superimpos$3) same (display with road adj2 lane$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:43
18	0	((overl$4 or superimpos$3) same (display with (road adj2 lane$3)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:43
17	4	((overl$4 or superimpos$3) same (display with (road adj2 line$3)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 06:51

19	23	((overl$4 or superimpos$3) and (display with (road adj2 line$3)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 07:17
22	0	((overl$4 or superimpos$3) and (display with (road adj2 center adj2 line$3)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 07:17
23	0	((non-motorized near2 vehicle) (motor near2 vehicle) car) and ((overl$4 or superimpos$3) same (display with road adj2 lane$3))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/03/29 07:20

US005499325A

United States Patent [19]

Dugan, Jr.

[11] Patent Number: 5,499,325

[45] Date of Patent: Mar. 12, 1996

[54] **BRIGHTNESS CONTROLS FOR VISUAL SEPARATION OF VECTOR AND RASTER INFORMATION**

[75] Inventor: **Robert F. Dugan, Jr.**, Kingston, N.Y.

[73] Assignee: **International Business Machines Corporation**, Armonk, N.Y.

[21] Appl. No.: **474,526**

[22] Filed: **Jun. 7, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 932,865, Aug. 20, 1992, abandoned.

[51] **Int. Cl.**[6] **G06T 5/00**; G09G 5/06; G09G 5/10

[52] **U.S. Cl.** **395/132**; 395/131; 395/161; 345/199; 345/147; 345/153

[58] **Field of Search** 395/132, 131, 395/161, 143, 135; 345/199, 153, 135, 147, 115, 113

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,458,330	7/1984	Imsand et al.	364/900
4,646,076	2/1987	Wiedenman et al.	340/747
4,716,546	12/1987	Beausoleil et al.	364/900
4,808,988	2/1989	Burke et al.	340/744
4,816,814	3/1989	Lumelsky	340/747
4,853,681	8/1989	Takashima	345/199
4,965,574	10/1990	Fukushima et al.	345/147 X
4,996,645	2/1991	Schneyderberg Van Der Zon	395/161 X
5,103,407	4/1992	Gabor	395/131
5,235,677	8/1993	Needle et al.	395/131
5,249,263	9/1993	Yanker	395/131
5,371,844	12/1994	Andrew et al.	395/161 X
5,428,739	6/1995	Maeda	395/161

OTHER PUBLICATIONS

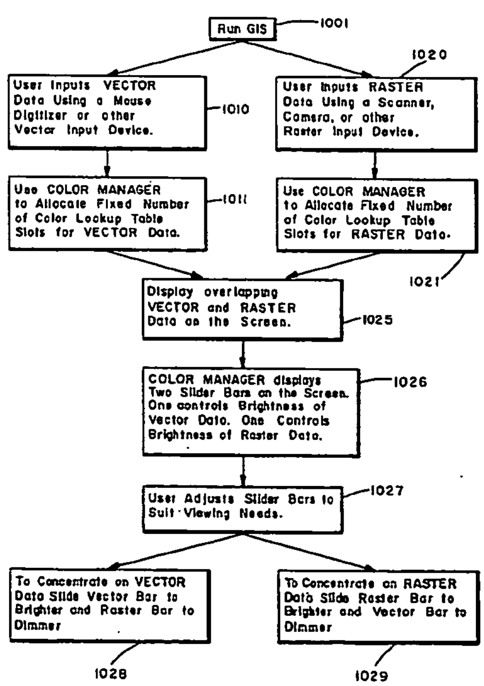
IBM Publication SH20-5621-04 entitled "Graphics Program Generator" Program Reference, Feb. 1990.

Primary Examiner—Raymond J. Bayerl
Attorney, Agent, or Firm—William A. Kinnaman, Jr.

[57] **ABSTRACT**

Methods and apparatus for aiding the user of graphics systems to visibly distinguish areas (images) on a display screen generated from raster data from areas on the same screen generated from vector data. An example of where the invention may be applied is in graphical systems in which geographic information is displayed with the graphic data being made up of both vector data (such as a set of points defining a road input to the system by the user via a digitizing tablet) and raster data (such as a photo image of the same road that is digitized via a scanner). The brightness of each data type (vector or raster) image being displayed may be modified by the user. In one embodiment of the invention, in response to user interaction with the system, the brightness of the raster data, the vector data, or both (and hence their images once displayed), may be modified by adjusting entries in color tables (or specific entries of a single color table) maintained for each data type. By changing the color specification entries in the color table(s), the vector and raster data subsequently output to a display can be distinguished based on the shift in brightness of the image appearing on the screen in response to the user action.

36 Claims, 9 Drawing Sheets



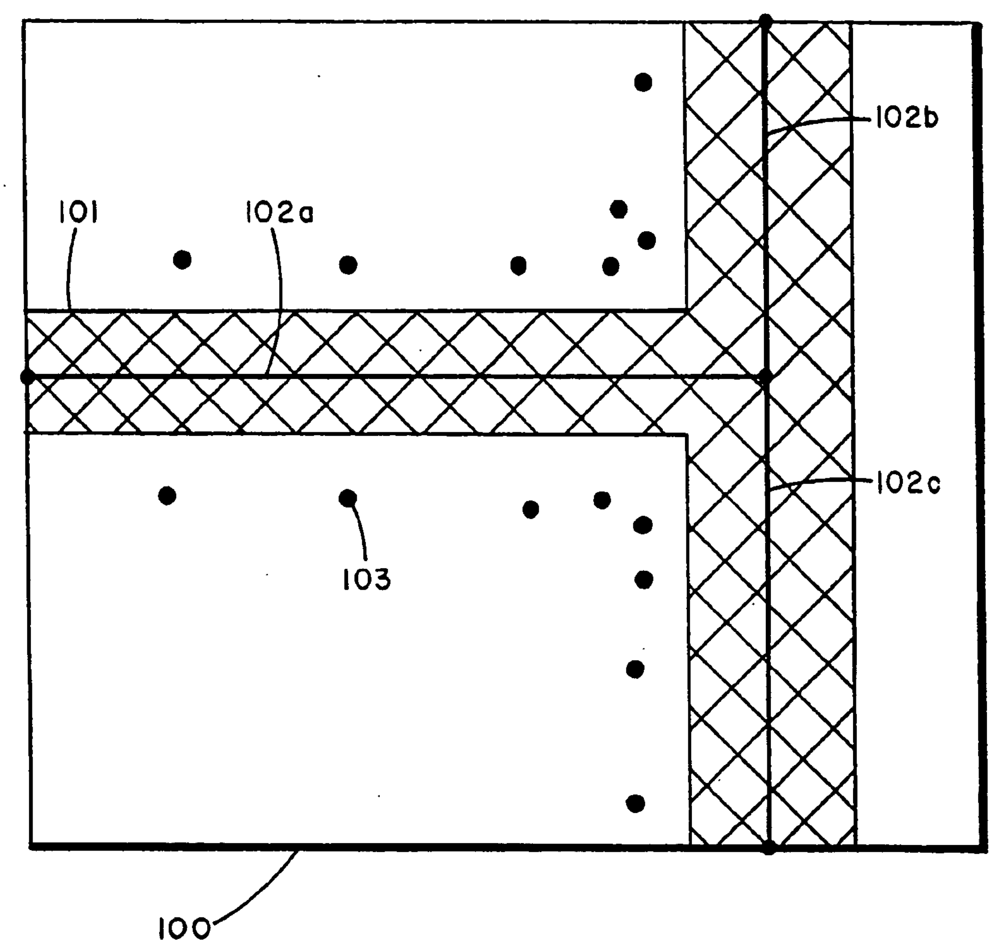
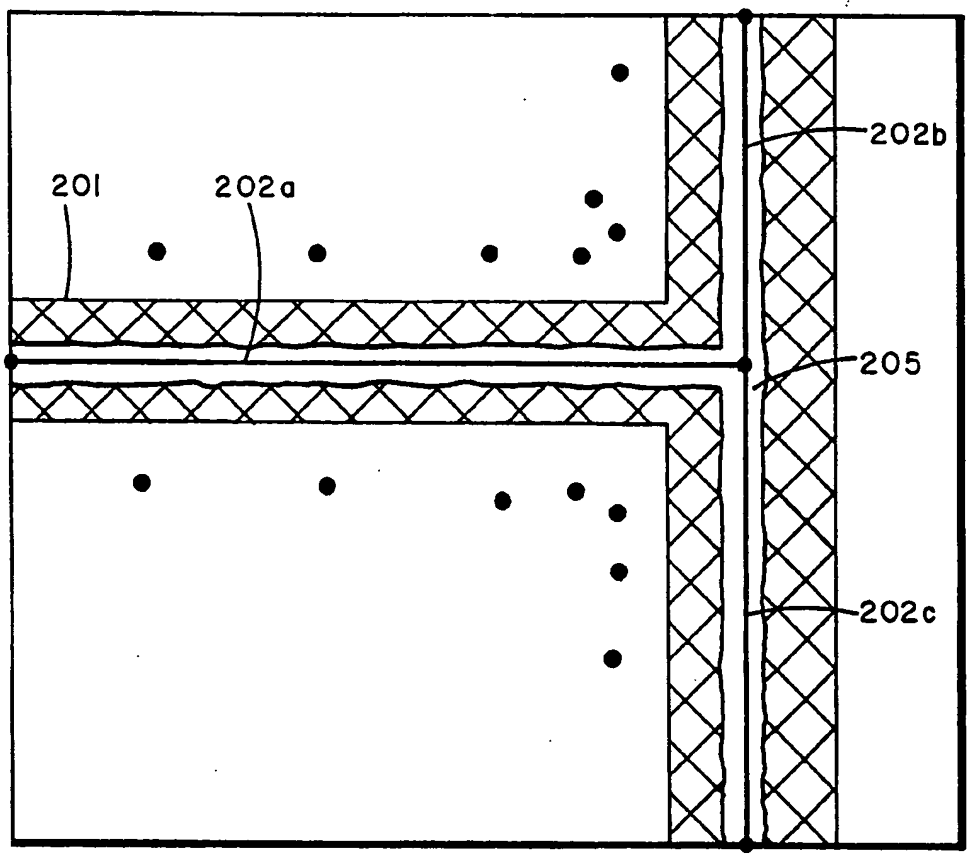


FIG. 1



PRIOR ART FIG. 2

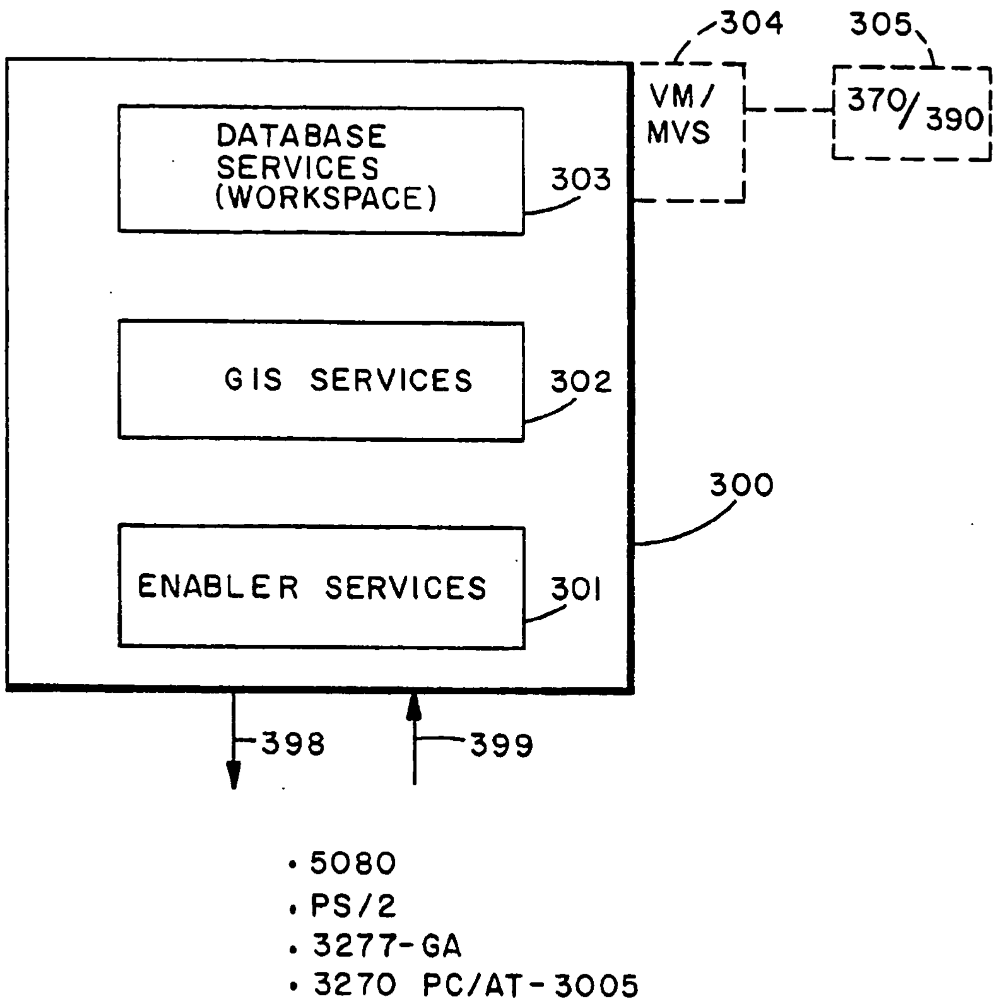

304
305
VM/
MVS
370/390
DATABASE
SERVICES
(WORKSPACE)
303
GIS SERVICES
302
300
ENABLER SERVICES
301
398
399
• 5080
• PS/2
• 3277-GA
• 3270 PC/AT-3005

FIG. 3

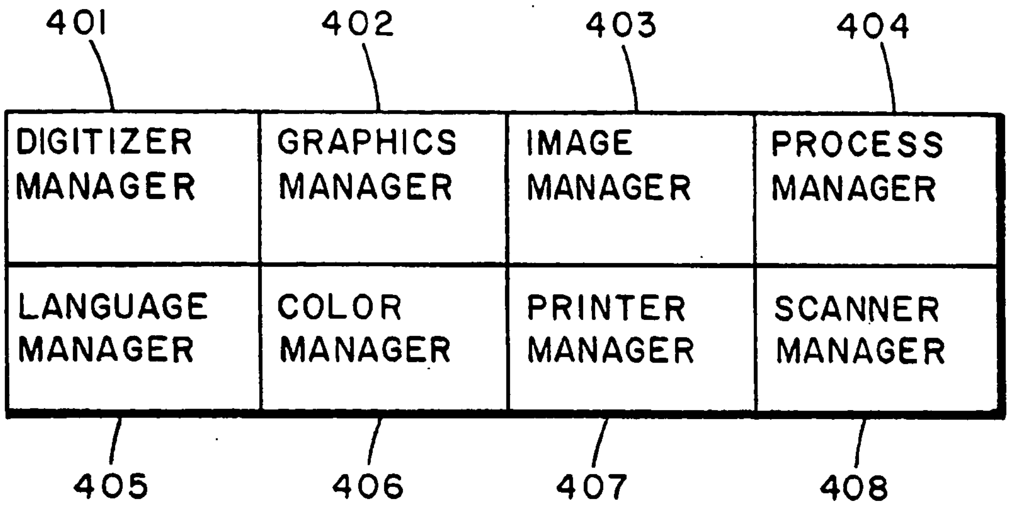


FIG. 4

RASTER COMMAND

draw_image (the Image)

VECTOR COMMAND(S)

set_color (SLOT 250)
draw_line (0,0,100,100)
draw_point (90,90)

FIG. 7

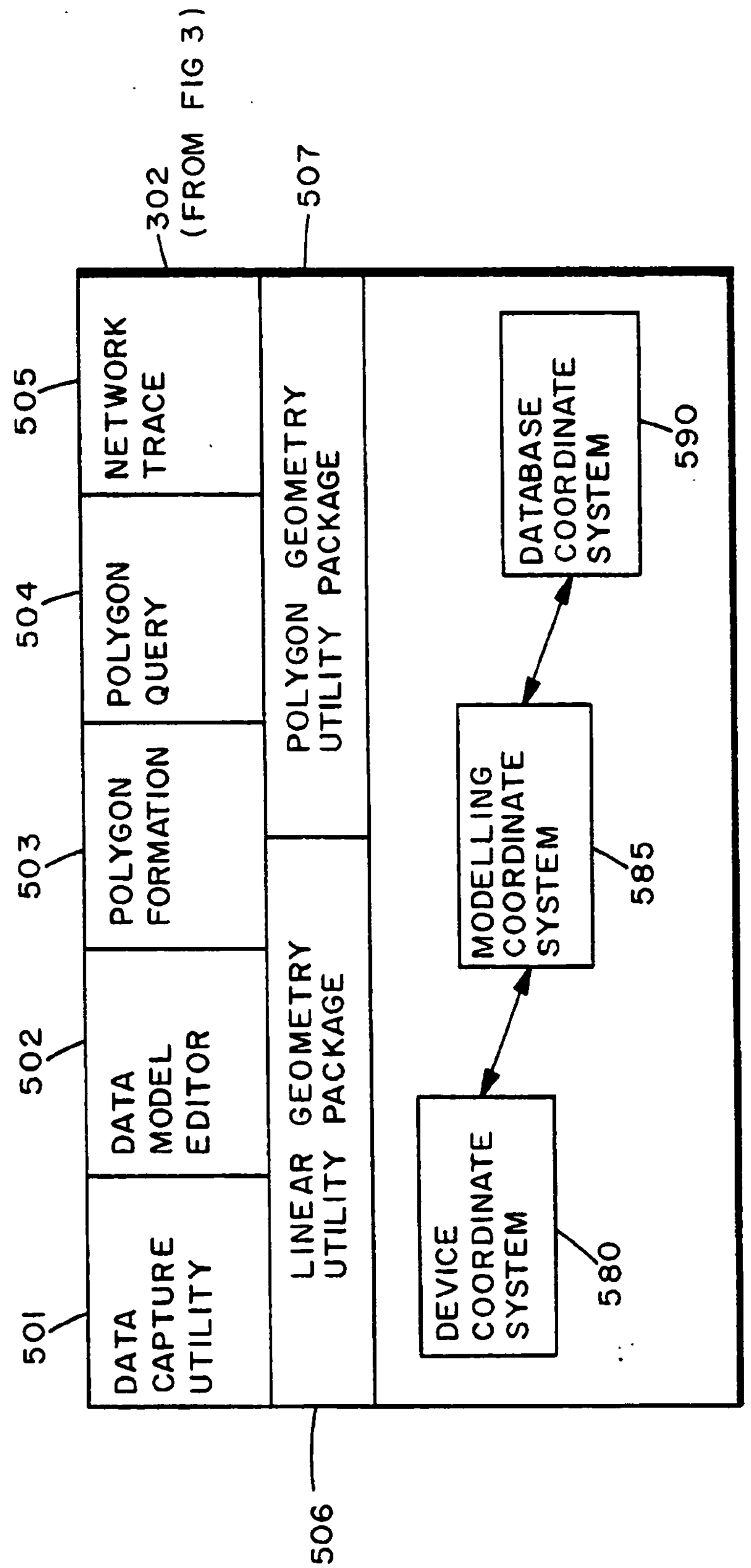

302 (FROM FIG 3)
507
505
504
503
502
501
NETWORK TRACE
POLYGON QUERY
POLYGON FORMATION
DATA MODEL EDITOR
DATA CAPTURE UTILITY
POLYGON GEOMETRY UTILITY PACKAGE
LINEAR GEOMETRY UTILITY PACKAGE
DATABASE COORDINATE SYSTEM
590
MODELLING COORDINATE SYSTEM
585
DEVICE COORDINATE SYSTEM
580
506

FIG. 5

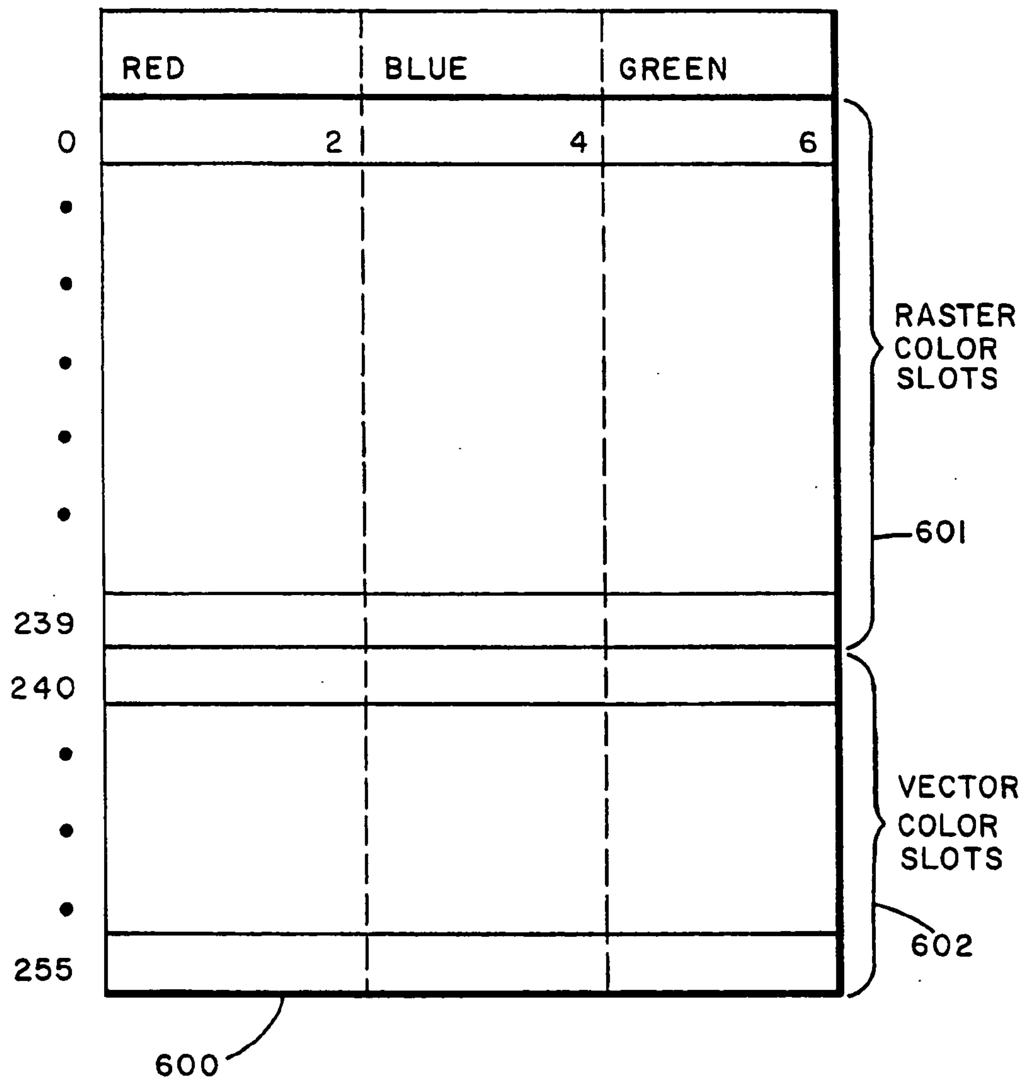
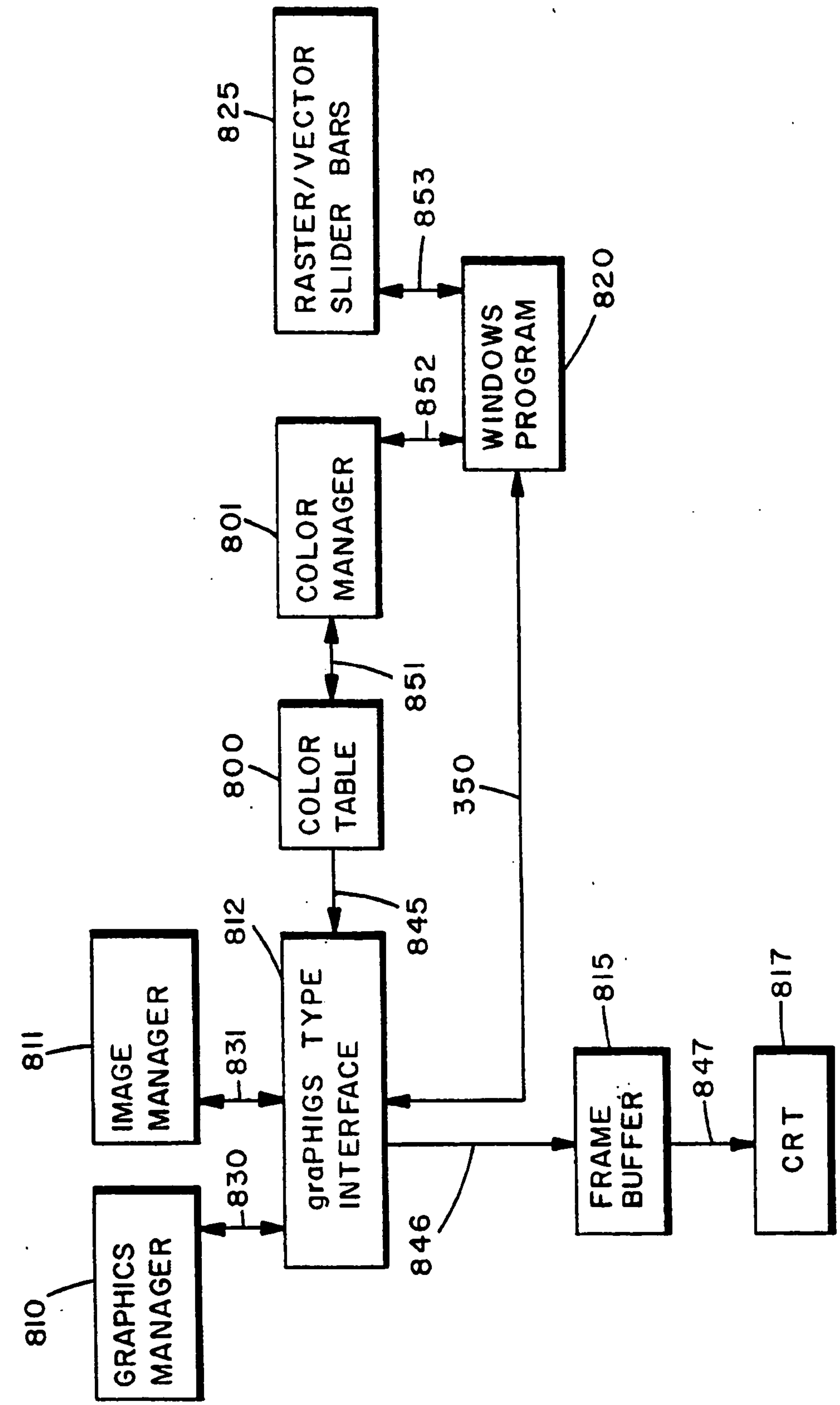

RED
BLUE
GREEN
0
2
4
6
239
240
255
RASTER COLOR SLOTS
601
VECTOR COLOR SLOTS
602
600

FIG. 6



RASTER/VECTOR SLIDER BARS
825
853
WINDOWS PROGRAM
820
852
COLOR MANAGER
801
851
COLOR TABLE
800
350
845
812
graPHIGS TYPE INTERFACE
IMAGE MANAGER
811
831
GRAPHICS MANAGER
810
830
846
FRAME BUFFER
815
847
CRT
817

FIG. 8

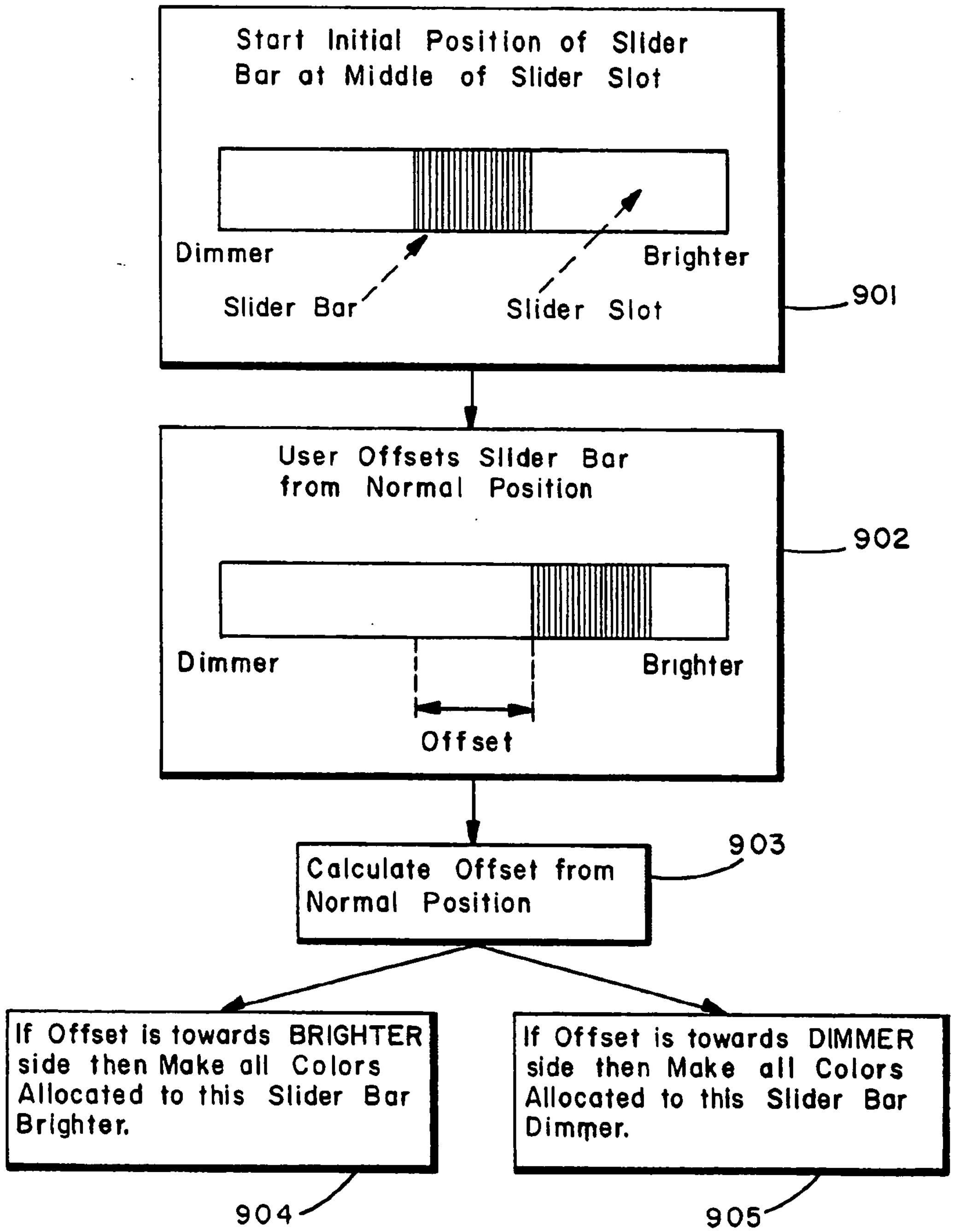

Start Initial Position of Slider Bar at Middle of Slider Slot
Dimmer
Brighter
Slider Bar
Slider Slot
901
User Offsets Slider Bar from Normal Position
902
Dimmer
Brighter
Offset
Calculate Offset from Normal Position
903
If Offset is towards BRIGHTER side then Make all Colors Allocated to this Slider Bar Brighter.
If Offset is towards DIMMER side then Make all Colors Allocated to this Slider Bar Dimmer.
904
905

FIG. 9

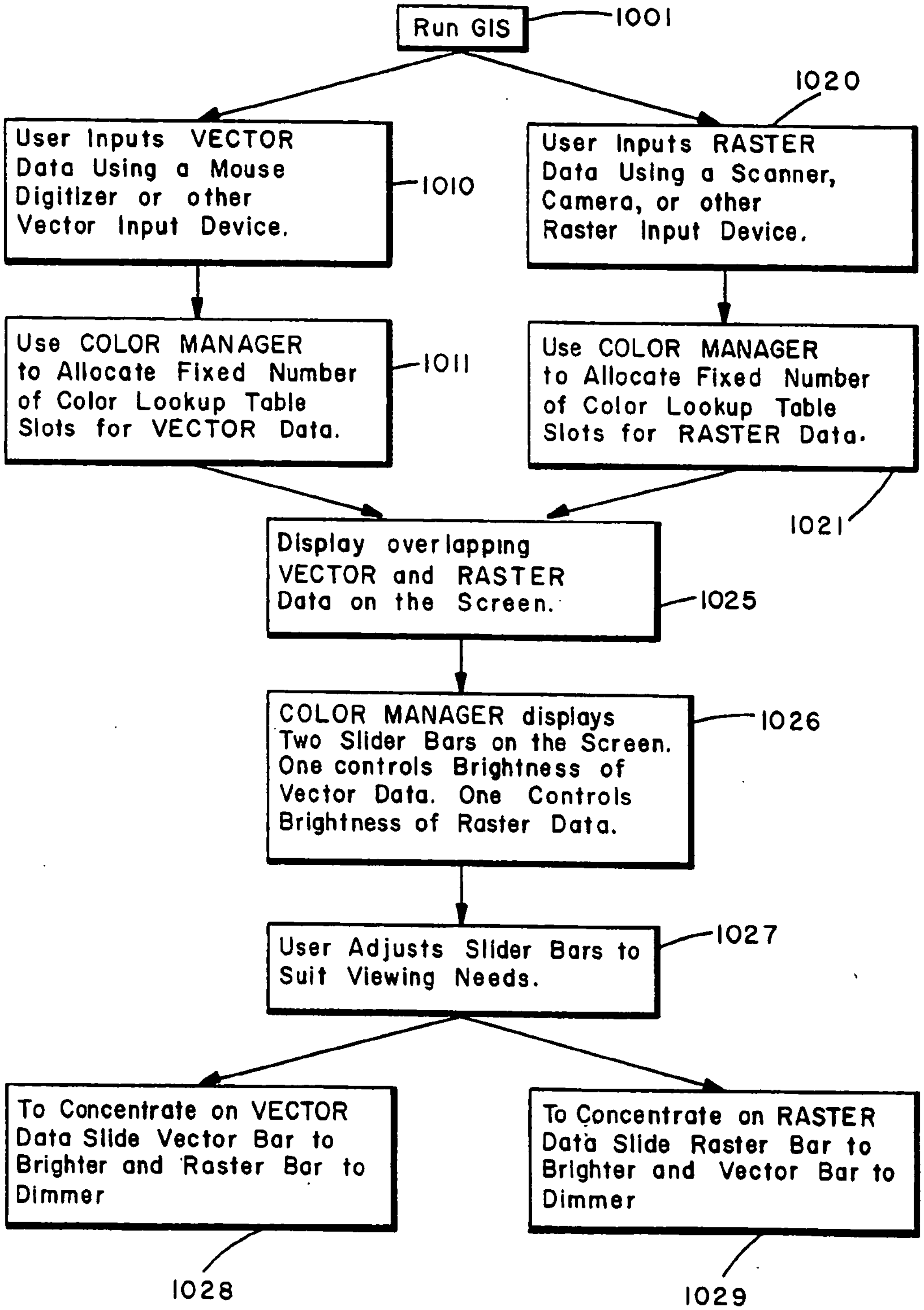

Run GIS
1001
User Inputs VECTOR Data Using a Mouse Digitizer or other Vector Input Device.
1010
User Inputs RASTER Data Using a Scanner, Camera, or other Raster Input Device.
1020
Use COLOR MANAGER to Allocate Fixed Number of Color Lookup Table Slots for VECTOR Data.
1011
Use COLOR MANAGER to Allocate Fixed Number of Color Lookup Table Slots for RASTER Data.
1021
Display overlapping VECTOR and RASTER Data on the Screen.
1025
COLOR MANAGER displays Two Slider Bars on the Screen. One controls Brightness of Vector Data. One Controls Brightness of Raster Data.
1026
User Adjusts Slider Bars to Suit Viewing Needs.
1027
To Concentrate on VECTOR Data Slide Vector Bar to Brighter and Raster Bar to Dimmer
1028
To Concentrate on RASTER Data Slide Raster Bar to Brighter and Vector Bar to Dimmer
1029

FIG. 10

BRIGHTNESS CONTROLS FOR VISUAL SEPARATION OF VECTOR AND RASTER INFORMATION

This application is a continuation of application Ser. No. 07/932,865, filed Aug. 20, 1992, now abandoned.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The invention relates generally to geometric modeling systems that, with the aid of a digital computer, may be used to capture, manipulate, analyze and report data. Examples of such systems include geographical positioning systems (GPS), geographic information systems (GIS), computer aided design (CAD) systems and computer aided manufacturing (CAM) systems.

More particularly, the invention relates to methods and apparatus used in geometric modeling systems for visibly distinguishing areas (images) on a display screen generated from raster data from areas on the same screen generated from vector data. An example of where the invention may be applied is in graphical systems in which geographic information is displayed with the graphic data being made up of both vector data (such as a set of points defining a road input to the system by the user via a digitizing tablet) and raster data (such as a photo image of the same road that is digitized via a scanner).

According to the invention, the brightness of each data type (vector or raster) image being displayed may be modified by the user. In one embodiment of the invention, in response to user interaction with the system, the brightness of the raster data, the vector data, or both (and hence their images once displayed), may be modified by adjusting entries in color tables (or specific entries of a single color table) maintained for each data type.

By changing color specification entries in each color table (or the color specification of assigned data type entries within a single color table), the vector and raster data that is subsequently output to a display can be distinguished based on the shift in brightness of the image appearing on the screen in response to the aforementioned user action.

The invention is particularly useful in situations where, in an exemplary application, raster data may assume any color in a defined color spectrum; making vector data and raster data indistinguishable by, for example, reassignment of color designations.

The invention may also be used in computer graphic systems which are not geometric modeling systems per se, to generally support graphics processing functions.

DEFINITIONS

The following terms and phrases are used herein and defined as follows:

1. A "modeling system" is a system that may be used to process (capture and manipulate) real world data and events, and process abstract data based on real world data and events. Examples of modeling systems include, but are not limited to, geographical positioning systems (GPS), geographic information systems (GIS), computer aided design (CAD) systems and computer aided manufacturing (CAM) systems.

2. A "modeling coordinate system" is a coordinate system which maps out a space that can completely contain all of the spatial or geometric data that a user can process using a given modeling system, in terms of a user's own units (e.g., feet, miles, degrees, etc.).

3. A "database coordinate system" is a coordinate system that accommodates the storage of data from a users modeling coordinate system without the loss of accuracy.

4. A "device coordinate system" is a coordinate system which maps out the available space on a given device (for example, a display device), into which data may be mapped. The data may, for example, be supplied via user interaction with a display device, may be mapped from (or to) a modeling coordinate system and/or database coordinate system, etc.

5. A "vector" is a line with a starting position, length and direction.

6. "vector data" is defined as data consisting of lines from which intelligent information (e.g., length, direction, etc.), can be derived.

7. A "raster" is a matrix covering the entire map in a database.

8. "raster data" is defined as a type of discrete data consisting of points corresponding to picture elements (pixels), where a database map image formed from the raster is a set of horizontal raster lines each made up of individual pixels.

DESCRIPTION OF THE PRIOR ART

In present day modeling systems which are used, for example, for GIS, GPS, CAD and CAM applications, it is well known to represent geometric map data using vector and raster data structures.

Such modeling systems typically operate under the control of, or with the aid of, a digital computer. An example of one such system is the commercially available IBM 5080 computer system on which the commercially available Graphics Program Generator (GPG) software may be executed ("IBM" is a trademark owned by the International Business Machines Corporation). The GPG software is described in IBM publication number SH20-5621-04, entitled "Graphics Program Generator Program Reference", fourth edition, copyright 1990, hereby incorporated by reference to describe a present day, commercially available system (the combination of the IBM 5080 hardware and GPG software) within which the invention may be applied.

It is well known that computers that support modeling systems, computer graphics systems (such as the IBM 5080), etc. may be used to process both vector data and raster data. The most common data structure used to represent geometric map data is the vector, i.e., a line with a starting position, length and direction as defined hereinabove.

Vectors have no width, but may have attributes assigned to them. For example, in some GIS's, vectors may have attributes such as street names, pipe serial numbers, etc.

The vector data structure is the most popular geometric map data organization for several reasons. First, traditional cartographic methods use vector operations. As a result, there are a greater number of flexible, refined vector algorithms than there are raster processing algorithms.

Second, many GIS users have made substantial commitments to vector data organization for geographic map data because of the large number of vector data bases already in

existence. In addition, many of these same users have invested in vector based hardware such as tablet digitizers, vector plotters and DVST technology.

Still further, since a vector description is a shorthand notation as compared to the alternative of providing the coordinates of every identifiable point between the end points of a line, vector notation greatly reduces the amount of data the must be stored in a computer to describe a line.

On the other hand, raster data structures are also very useful for organizing geometric map data. Features are stored in such a data structure in terms of their component points (pixels). The map image is formed from the raster, a set of horizontal raster lines each made of individual pixels. Simply stated, the raster is a matrix covering all or a portion of the map in the data base. Almost all modem graphics and automatic data capture systems use raster technology.

Since the number of well developed vector processing algorithms in existence today exceed the number of raster processing algorithms, raster data is often converted to vector format for processing purposes. On the other hand, for display purposes, vector data is often converted to raster format i.e., is "rasterized" for output to matrix plotters, raster television systems and the like.

Display systems are well known which can accommodate the concurrent display of both vector and raster data. One example of a display system that facilitates outputting and displaying both vector and raster data simultaneously is taught by Imsand et al in U.S. Pat. No. 4,458,330.

In the Imsand et al reference, by way of example, a raster television system is used as an output display device and vector data is converted to raster format prior to being output to the display device.

Once converted to raster data, there is no way taught or suggested in the Imsand et al reference for the user to distinguish which portion of the output was generated from the raster data and which portion of the output was generated from the vector data when both data types (with the vector data having been converted to raster format) are simultaneously viewed.

Beausoleil et al in U.S. Pat. No. 4,716,546, teaches a system capable of displaying both vector and raster data on a display subsystem cathode ray tube. The Beausoleil et al reference specifically teaches a display memory organization optimized for the writing and displaying of vectors on the display system where the refresh memory system is directed to a raster scan organization with the display being divided into pixels which are updated line by line.

Once again, although capable of displaying both vector and raster data simultaneously, the user has no way of distinguishing whether the data being displayed was originally vector or raster data.

In addition to the cathode ray tube display systems taught in the above referenced patents in which a beam is caused to trace a repetitive pattern of parallel scan lines and the information is presented by intensity modulating the electron beam at the appropriate points along each line (i.e., a raster display system), stroke written cathode ray tube displays are known which trace the shape of figures to be presented by deflection of an electron beam in a manner which connects a successive sequence of strokes, which may be straight or curved.

Further yet, hybrid cathode ray tube displays are also known which include a conventional stroke vector generator and a conventional raster symbol generator to sequentially supply a CRT with a picture that includes both raster and stroke vector information.

One such hybrid display system, taught by Grothe in U.S. Pat. No. 4,631,532, includes apparatus for superposing a raster symbol display and a vector symbol display on a single cathode ray tube. In an improvement to Grothe as set forth by Grothe et al in U.S. Pat. No. 4,635,050, a masking technique is taught in which the display is energized by the stroke vector signals and responds preferentially to a priority symbol allowing a portion of the display to be masked within selected regions.

According to the Grothe et al reference, the display is sequentially and alternately energized by the stroke vector positional signals and the raster symbol character signals, thereby providing a display comprised of a raster symbol character display superimposed on a stroke vector display, with the raster disposed to preferentially mask stroke vector characters of lesser priority.

By masking the stroke vector signal at the point of intersection with a raster scan line, the stroke vector display may be blanked in selected areas, with a raster scan optionally superimposed thereon (and vice versa).

Although the Grothe and Grothe et al references teach display systems which facilitate the concurrent visualization of vector and raster type data, there is no way of distinguishing between the two data types other than to use the computationally intensive and hardware oriented blanking scheme taught in Grothe et al (i.e., to suppress one data type on a priority basis while allowing the other type to be displayed in instances where an overlap occurs). The blanking scheme requires special purpose hardware which is expensive and not easy to retrofit into systems not designed to support the blanking and clipping processes.

Burke et al, in U.S. Pat. No. 4,808,988, in the context of describing a digital vector generator for a graphics display system, teaches the use of a color map to convert video data output to a display to a predetermined three color RGB (Red/Green/Blue) representation with 8 bits maximum per color. The color map allows a particular intensity and hue to be assigned sequentially to each pixel being illuminated on the display surface.

The aforementioned IBM 5080 computer system is a commercially available example of a computer system having a graphics subsystem that utilizes a color map to specify colors for both vector and raster data being output to a display.

Since many types of graphics data (such as GIS graphics data) consists of both vector and raster information (where both types of information can cover the same geographic region in the GIS example), it would be desirable to be able to visibly distinguish areas on a display screen generated from raster data, from areas on the same screen generated from vector data.

Visually, the images of raster and vector data displayed on a screen do not always complement each other. Often it is hard to tell where an image generated from vector data leaves off and an image generated from raster data begins. By having the capability to visually separate graphics data images to distinguish vector data images from raster data images, a user could, for example, check the accuracy of vector data against raster data (for instance, answer questions like "Did the road that was digitized from a map actually follow the image photograph of the road?); create vector data using the raster data as a reference (for instance, digitize a road directly on a graphics screen using an image photograph of the road); and create a frame of reference, a particularly useful tool in geographic areas where there is not a lot of vector data (in this case raster data can provide an excellent frame of reference).

In view of the prior art as exemplified by the aforementioned references, it would also be desirable to be able to visually separate images generated from raster data from images generated from vector data, on the same display screen, without having to use computationally intensive processes that consume system resources (in particular, CPU time), or require the use of expensive hardware to implement hardware oriented blanking and clipping techniques.

Furthermore, it would be desirable to be able to provide a technique for visually separating images generated from raster data, from images generated from vector data (on the same display screen), which do not clip or blank out any data from the screen, leaving all displayed data visible while distinguishing the two data types.

Still further, it would be desirable to be able to accomplish the aforementioned visual separation quickly and efficiently, in real time under user control, utilizing the existing display hardware configuration in a given modeling system or computer graphics system. In particular, it would be desirable to be able to accomplish the desired visual separation utilizing techniques that only need to modify color table entries for a given data type (vector or raster data), in response to user generated requests to change the brightness of a particular data type. Such techniques are easily implemented in software, are not computationally intensive and do not require the addition of expensive special purpose hardware to the underlying system.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to be able to provide methods and apparatus for visibly distinguishing areas on a display screen generated from raster data (raster data images), from areas on the same screen generated from vector data (vector data images).

It is a further object of the invention to be able to provide methods and apparatus for performing the aforementioned visual separation without having to use computationally intensive processes that consume system processing resources or require the use of expensive hardware to implement blanking and clipping schemes.

Furthermore, it is an object of the invention to be able to provide a methods and apparatus for visually separating images generated from raster data, from images generated from vector data (on the same display screen), which do not clip or blank out any data (i.e., suppress any displayed images) from the screen; as opposed to the use of techniques which suppress image generation to distinguish data type resulting in visual data loss.

Further yet, it is an object of the invention to be able to provide methods and apparatus which accomplish the aforementioned visual separation quickly and efficiently, in real time under user control, utilizing the existing display hardware configuration in a given modeling system or computer graphics system.

A still further object of the invention is to be able to accomplish the desired visual separation of vector and raster data type images utilizing techniques that are not computationally intensive, that are amenable to software implementation and do not require the addition of expensive special purpose hardware to the host system.

According to the invention, the aforementioned objectives may be achieved by using methods and apparatus which allow a user to control the brightness of each type of data image (vector and raster data images) appearing on a display device, via modification of the value of data type oriented color specification entries in the existing color table(s) in a given modeling or computer graphics system.

In accordance with one embodiment of the invention, a method is set forth for enabling images on a display screen generated from raster data to be visually distinguished from images on the same screen generated from vector data (in the context of a modeling system that includes dedicated color table entries for specifying the color of raster data and vector data), comprising the steps of: (a) controlling the brightness of raster data images on the screen in response to a first control signal generated by a first control means; and (b) controlling the brightness of vector data images on the screen, in response to a second control signal generated by a second control means.

According to a further aspect of the invention, the aforementioned step of controlling the brightness of raster data images in response to the first control signal includes the step of modifying all color table entries specifying the color of raster data in the system by a first adjustment factor. Likewise, the aforementioned step of controlling the brightness of vector data images in response to the second control signal includes the step of modifying all color table entries specifying the color of vector data in the system by a second adjustment factor.

According to a another aspect of the invention, the aforementioned first adjustment factor is added (subtracted) to the red, green and blue components of each color table entry specifying the color of raster data in the system to increase (decrease) the brightness of raster data; while the aforementioned second adjustment factor is added (subtracted) to the red, green and blue components of each color table entry specifying the color of vector data in the system to increase (decrease) the brightness of vector data.

A preferred embodiment of the invention contemplates the aforementioned first and second adjustment factors being variable quantities which depend on the magnitude of the first and second control signals, respectively. In accordance with an alternate embodiment of the invention, the first and second adjustment factors are fixed quantities.

Still another embodiment of the invention is directed to a method for distinguishing raster data display images from vector data display images in a modeling system in which both raster data and vector data display images are simultaneously viewable in the same display window, in the context of a system that includes a cathode ray tube (CRT) having a defined display window, a color table for storing color specifications assigned to data to be displayed on said CRT (wherein each color table entry is dedicated to specifying the color intensity of either raster data or vector data), a color manager for modifying color table entries in response to user input control signals, control means for inputting the control signals, a graphics manager for processing vector commands, and an image manager for processing raster commands.

According to this aspect of the invention, the novel method comprises the steps of: (a) predefining a first set of color table entries as vector data entries and predefining a second set of color table entries as raster data entries; (b) increasing the color intensity of the first set of color table entries via the color manager in response to a first control signal input to the color manager by the user via the control means; (c) decreasing the color intensity of the first set of color table entries via the color manager in response to a second control signal input to the color manager by the user via the control means; (d) increasing the color intensity of the second set of color table entries via the color manager in

response to a third control signal input to the color manager by the user via the control means; and (e) decreasing the color intensity of the second set of color table entries via the color manager in response to a fourth control signal input to the color manager by the user via the control means.

Further steps in the embodiment of the invention, described immediately hereinabove include (a) periodically refreshing the CRT to display vector and raster images corresponding to the vector and raster commands processed by the graphics manager and image manager; and (b) updating the display to adjust the brightness of display images starting with a refresh cycle following the color intensity in said color table having been modified for at least one data type, thereby allowing a user to distinguish between vector data images and raster data images being displayed.

According to a preferred embodiment of the invention, the methods contemplated herein are easily implementable in software, with a visible control in the form of a dial widget or slider bar appearing next to the graphic field of view. By changing all of the color table entries for each data type in response to user inputs (via the dial widget or slider bar), the raster and vector data can easily be distinguished as presented on the display screen.

Further aspects of the invention are directed to apparatus for distinguishing raster data display images from vector data display images in a computer graphics system in which both raster data and vector data display images are simultaneously viewable in the same display window.

According to a preferred embodiment of the invention, such apparatus is incorporated into a system that includes a cathode ray tube (CRT) having a defined display window, a vector command processor and a raster command processor, where (in the system) a first set of color specifications are defined for raster type data and a second set of color specifications are defined for vector type data.

The novel apparatus in the context of this system comprises: (a) color specification storage means, for storing color specifications assigned to data to be displayed on the CRT, wherein each entry stored in the color specification storage means is dedicated to specifying the color intensity of either raster data or vector data and further wherein the color specification storage means is initialized with the first and second sets of color specifications; (b) user input control means for inputting a user request to the system, in the form of at least one brightness control signal, to change the brightness of at least one type of data image displayed on the screen; and (c) color specification modification means, for modifying color specification storage means entries in response to the at least one brightness control signal, operative to modify all the entries in the first set of color specifications stored in the color specification storage means whenever the at least one control signal indicates that the brightness of raster data is to be modified, and operative to modify all the entries in the second set of color specifications stored in the color specification storage means whenever the at least one control signal indicates that the brightness of vector data is to be modified.

Still other aspects of the invention are directed to more general methods for selectively controlling the brightness of raster data images and vector data images on a display device in any color graphics system that includes dedicated color table entries for specifying the color of raster and vector data types.

The invention features the ability to easily and independently control the brightness of raster and vector data images appearing on a display screen to assist a user in visually distinguishing between these two data types in modeling systems and computer graphics systems where images generated from the two data types can be simultaneously displayed.

As indicated hereinbefore, an example of one such system is the IBM 5080 running GPG software. This GIS allows both raster data and vector data to be placed into a frame buffer before generating the corresponding raster and vector data images on a CRT, thereby allowing both types of data to be simultaneously displayed. The aforementioned GIS uses the convention that vector data is placed into the frame buffer after raster data for each frame to be displayed so that the vector data (usually in the form of line segments) is not overwritten by the raster data (usually in the form of patterns that would obliterate underlying vector data). This convention is assumed to be followed in any system employing the invention that allows both data types to be written to a single frame buffer before generating the data images on a CRT.

Further features of the invention include being able to perform the aforementioned visual separation without having to use computationally intensive processes that consume system processing resources or require the use of expensive hardware to implement blanking and clipping schemes; enabling a user to visually separate images generated from raster data from images generated from vector data (on the same display screen), while not clipping or blanking out any data; and being able to accomplish the aforementioned visual separation quickly and efficiently, in real time under user control, utilizing the existing display hardware configuration in a given modeling system or computer graphics system, using techniques that are amenable to software implementation and which are easy to retrofit into existing commercially available graphics systems.

These and other objects and features of the present invention and the manner of obtaining them will become apparent to those skilled in the art, and the invention itself will be best understood by reference to the following detailed description read in conjunction with the accompanying Drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts an example of the raster data image of a road being displayed on a screen (e.g., a cathode ray tube), together with a vector data image of the same road.

FIG. 2 depicts how prior art masking techniques (hardware oriented blanking or clipping schemes) can be used to visually separate and highlight the vector data image from the raster data image depicted in FIG. 1.

FIG. 3 depicts in block diagram form the elements of an exemplary prior art modeling system in which the invention may be advantageously used. In particular, FIG. 3 depicts portions of a commercially available Geographic Information System (GIS) in which the invention may be practiced.

FIG. 4 depicts in greater detail the Enabler Services portion of the exemplary GIS system depicted in FIG. 3. In particular, FIG. 4 depicts color specification modification means (the depicted "color manager") which, according to the teachings of the invention, can be made to respond to user input signals to alter the color specifications for raster data and/or vector data maintained in a color table.

FIG. 5 depicts in greater detail the GIS Services portion of exemplary GIS system depicted in FIG. 3.

FIG. 6 depicts an exemplary color table that includes color specification entries for both raster data and vector data. The color table depicted in FIG. 6 is typically stored in

memory accessible by the color manager depicted in FIG. 4, with the memory being an example of the color specification storage means referred to hereinafter,

FIG. 7 depicts a set of exemplary prior art graphics commands which are executed and re-executed in a display subsystem to continuously update and refresh the image displayed on a display device.

FIG. 8 depicts a prior art hardware configuration which supports a preferred embodiment of the present invention. Such a configuration includes software, in the depicted color manager, operating in accordance with the teachings set forth herein, to modify color specification entries in (for example) the color table depicted in FIG. 6.

FIG. 9 depicts how a slider bar may be used, in accordance with one embodiment of the invention, to control the bright of displayed data images.

FIGS. 10 depicts, in the form of a summary flow chart, the user interaction and resulting process steps contemplated by a preferred embodiment of the invention.

DETAILED DESCRIPTION

FIGS. 1–2 illustrate the type of problem that can be solved utilizing the present invention.

FIG. 1 depicts an example of the raster data image of a road (cross-hatched data image **101**), being displayed on display surface **100** together with a vector data image of the same road (line segments **102a**, **102b** and **102c**). The other symbols appearing on display surface **100** in FIG. **1**, such as the feature labeled **103**, are meant to represent structures adjacent to the depicted roadway such as trees, etc.

The convention of placing raster data into a frame buffer, followed by placing any vector data to be displayed into the same frame buffer, is assumed to have been followed. Normally, such a buffer is "flushed" after the images to be displayed are generated. The buffer is then normally refilled during the next display cycle, in accordance with well known graphics processing techniques, to implement display commands that have been input to the system.

Assuming, for example, that raster data can be any color in a defined color spectrum, it would be impossible to visibly distinguish the raster data image from the vector data image depicted in FIG. **1**, based on color alone. This is an example of one type of problem solved by the present invention.

A prior art approach for highlighting the vector data is, as indicated hereinbefore, the use of hardware oriented blanking and clipping techniques, such as those taught in the aforementioned Grothe et al reference. Utilizing such techniques, a region surrounding the vector data image could be "blanked out" (shown as region **205** in FIG. **2**), thereby highlighting the vector data image (line segments **202a**, **202b** and **202c** corresponding to line segments **102a**, **102b** and **102c** in FIG. **1**), at the expense of losing some of the previously visible raster data image (**101** in FIG. **1**), shown as raster data image **201** in FIG. **2**.

The invention described herein allows the vector data image in FIG. **1** to be visually distinguished from the raster data image of FIG. **1** without requiring the use of any special purpose hardware or requiring the aforementioned hardware oriented blanking and clipping techniques to be applied. Consequently, the aforementioned data loss problem can also be solved by utilizing the present invention.

According to the invention, the raster data image and vector data image depicted in FIG. **1** are distinguished by controlling the brightness of each data type being displayed.

According to a preferred embodiment of the invention, the brightness of each data type can be controlled independently, with each data type image being made brighter, dimmer or held at the same intensity, under user control. Alternatively, the invention also contemplates systems where the user controls the intensity of both data types in a dependent fashion, i.e., whenever the intensity of the image corresponding to one data type is intensified, the other data type image is automatically reduced in intensity.

These and other embodiments of the invention will be explained in greater detail hereinafter following a brief description (set forth for the sake of completeness) of an exemplary geometric modeling system, a GIS, (described with reference to FIGS. **3–5**), in which the invention may be used.

Reference should now be made to FIG. **3** which depicts in block diagram form the elements of the exemplary GIS. Such systems are well known by those skilled in the art.

The exemplary GIS system depicted in FIG. **3** may be realized by a combination of the aforementioned GPG software, as described in the previously incorporated reference, and, for example, the aforementioned IBM 5080 computer system, operating in a IBM System 370/390 environment. The GPG software, IBM 5080 and IBM 370/390 computers referred to hereinabove are all commercially available hardware and software products.

Other computer systems that can support the illustrative GPG GIS system in the exemplary system 370/390 environment include commercially available IBM PS/2 products, the IBM 3277-GA and the IBM 3270 PC/AT-3005. Each of the aforementioned products typically include a display (CRT), mouse, optional digitizer, and keyboard for allowing the user to interface with GIS **300** (as depicted in FIG. **3**) via the Enabler Services **301** portion of GIS **300**, also depicted in FIG. **3** and described in greater detail with reference to FIG. **4**.

Commercially available software packages, such as Microsoft Windows Version 3.1 ("Microsoft" and "Windows" are trademarks of the Microsoft Corporation), running on, for example, the IBM PS/2 (shown coupled on links **398–399** to GIS **300** in FIG.**3**), can be used to present the user with slider bars, dial widgets, etc. (displayed on the CRT), and serve as an example of an interface between the user and the Enabler Services **301** portion of GIS **300** for supporting the invention being described herein.

Generally speaking, the Enabler Services **301** portion of a GIS system (like GIS **300**), services input/output requests between the user and the rest of the GIS system. The Enabler Services **301** portion of exemplary GIS **300** (depicted in greater detail in FIG. **4**), is shown (in FIG. **4**) to include (**1**) digitizer manager **401**; (**2**) graphics manager **402**; (**3**) an image manager **403**; (**4**) process manager **404**; (**5**) language manager **405**; (**6**) color manager **406**; (**7**) printer manager **407**; and (**8**) scanner manager **408**. Managers **401–408** (i.e., managers capable of performing the functions ascribed to each of the aforementioned managers, all of which are discussed hereinafter), are commercially available having been implemented as part of the GPG software referred to hereinabove and in other graphics systems.

Digitizer manager **401** (in the GPG context) is used to collect information (vector type data) from a digitizing tablet and input the information into GIS **300**. In the same context, graphics manager **402** is used to manage the input/output of vector data to/from a display screen; image manager **403** is used to manage the output of raster data to a display screen; process manager **404** is used to manage all communication

and programs in the entire GIS 300; language manager 405 is used to interpret applications programs; color manager 406 is used to control screen color; printer manager 407 is used to output information to a printer; and scanner manager 408 is used to manage the input of raster data to the GIS.

The next portion of GIS 300 depicted in FIG. 3 is the hardware and software making up GIS Services portion, 302 of the system. Several typical GIS Services, such as those provided by the aforementioned GPG software, are identified and will be explained in greater detail hereinafter with reference to FIG. 5. For now it is sufficient to say that these services could be, for example, CAD/CAM services, GPS services, accounting services, etc., and involve (1) the capture of data (for example, a mouse pointing to a river bed and tracing the river over a screen); (2) the manipulation of data (for example, moving a road on a map, moving the location of a fire hydrant, etc.); (3) the analysis of data (such as solving minimum distance determination problems); and (4) reporting the results of GIS Services processing (for example, generating a report, plotting points and/or drawing points on a display screen, etc.).

FIG. 3 also depicts a Database Services portion 303 of GIS 300, which manages work space (also contained within Database Services portion 303 of GIS 300) allocated to the GIS Services portion 302 of GIS 300; and an operating system 304 (such as, for example, the commercially available VM or MVS operating system), for managing the interface between GIS 300 and a host computer (a main frame interactive product), such as the aforementioned IBM System 370/390 computer (shown at 305 in FIG. 3).

As indicated hereinabove, FIG. 5 depicts in greater detail the GIS Service portion (portion 302 in FIG. 3) of the exemplary GIS system 300 depicted in FIG. 3. The exemplary GIS Services portion 302 is shown to include (usually in the form of software) a data capture utility (501); a data model editor (502); polygon formation and polygon query sections (503 and 504, respectively); a network trace section (505); linear and polygon geometry utility packages (506 and 507, respectively); and software (not shown in FIG. 5) for converting between a set of defined coordinate systems, such as the device, modeling and database coordinate systems depicted in FIG. 5 at 580, 585 and 590 (with the various coordinate systems being defined as set forth hereinbefore).

The data capture utility 501 may be used to capture data input to GIS 300 via Enabler Services 301, by, for example, the aforementioned mouse pointing to a river bed and tracing the river over a screen coupled to GIS 300.

Data model editor 502 may, for example, be used to perform a data analysis function which involves obtaining a solutions to the aforementioned minimum distance determination problems.

Polygon formation section 503 and polygon query section 504; may be used to literally form polygons given a set of data points, to analyze data in such a way as to answer questions such as "How close is the nearest fire hydrant to a piece of property represented by a given polygon?",etc

Network trace section 505 may be used, for example, to determine the shortest path between two nodes in a given network.

The linear geometry utility package 506 depicted in FIG. 5 may, for example, be used to compute the distance between two or more points, solve minimum distance determination problems, etc., when called upon to do so by, for example, data model editor 502. Likewise, polygon geometry utility package 507, may, for example, be used to compare the area of parcels, determine the length of the perimeter of an object, etc.

The known processes for distinguishing between vector data images and raster data images (hardware oriented blanking and clipping schemes, etc., as described hereinbefore), do not utilize any utilities like those found in the Enabler Services portion 301 of GIS 300 (usually implemented in software), to achieve their objectives.

By way of contrast, as will become clear with reference to the description of the invention being set forth herein, the present invention takes advantage of a utility like color manager 506 in the exemplary system, and a color table stored as a data set in, for example, color specification storage means to which the color manager is coupled, to distinguish between vector data images and raster data images displayed on a CRT. In fact, according to one embodiment of the invention, color manager 506 (under user control), in the exemplary system, is used as color specification modification means. In other words, color manager 506 is used to modify color table entries associated with raster data, vector data, or both, under user control, to affect the brightness of displayed data images.

Before describing an illustrative embodiment of the invention per se, reference should be made to FIGS. 6–7 which depict an exemplary color table that includes color specification entries for both raster data and vector data (FIG. 6), and a set of exemplary prior art graphics commands (shown in FIG. 7) which are executed and re-executed in a display subsystem to continuously update and refresh the image displayed on a display device.

The illustrative color table 600 shown in FIG. 6, is divided into two portions (which could of course be separate tables as well), a first portion, 601, in which all the entries (slots) are reserved for specifying the color of raster data; and a second portion, 602, in which all the slots are reserved for specifying the color of vector data.

As indicated hereinabove, a partitioned color table in which raster and vector data are intentionally stored in mutually exclusive portions of the table, like table 600, is (according to the teachings of the invention and not the prior art) typically stored in a data set in storage means (referred to herein as color specification storage means) associated with a display subsystem.

The use of such tables for storing entries which are associated with "typed data" (specifically refresh and non-refresh data) is well known and is used, for example, in the commercially available IBM GPG GIS system, running on the IBM 5080, referred to hereinabove. By way of contrast, the prior art does not teach or suggest the use of a color entry table partitioned into mutually exclusive sets of raster and vector data entries for any purpose, let alone for the purpose of controlling brightness. Those skilled in the art will readily appreciate that there is no correlation between refresh/non-refresh data and raster/vector data. For example, vector data can be both refresh and non-refresh data and the same holds true for raster data.

The illustrative color table depicted in FIG. 6 goes on to show a table structure similar to the one described in the aforementioned Burke et al reference, i.e., a structure where each entry includes a byte for specifying the intensity of the red, blue and green content of data being displayed. Color tables, such as the one depicted in FIG. 6, facilitate the sequential assignment of a particular intensity and hue for each pixel being illuminated by a display subsystem on a display surface.

The red, blue and green components of each color specification entry (i.e., the bytes referred to in the Burke et al patent), are also shown in FIG. 6, with the illustrative values

"2", "4" and "6" being stored in slot 0 (one of the 240 slots to which raster data may be assigned using the illustrative table 600).

Reference should now be made to FIG. 7 which, as indicated hereinabove, depicts a set of exemplary prior art graphics commands which are executed and re-executed in a display subsystem to continuously update and refresh the images displayed on a display device. Suitable commercially available applications programming interfaces for processing the exemplary commands depicted in FIG. 7 are GASP and graPHIGS ("GASP" and "graPHIGS" are trademarks owned by the International Business Machines Corporation).

The command types depicted in FIG. 7 allow users to interact with a graphics system and, for example, enable a user to draw an image (utilizing the depicted raster command "draw_image (the Image)"), which, in the exemplary GPG GIS system in which the invention is being described, results in an array of 1024×1024 bytes, with each byte having a number which corresponds to an index into the aforementioned color table.

A command like "draw_image (the Image)", would, according to the illustrative GPG GIS system in which the invention is being described, be initially processed by the aforementioned image manager 403 (shown in FIG. 4), and then be processed by the aforementioned GASP interface (sometimes referred to hereinafter as a graPHIGS type interface) which creates the rendering to be displayed on the display screen. The graPHIGS type interface also maintains the commands that are being executed in a display list buffer. The commands being processed are continually executed and reexecuted by a facility such as GASP or graPHIGS, to refresh a frame buffer located, in the exemplary IBM system 5080 context, in the display subsystem.

Before actually causing an image to be drawn, the graPHIGS type interface utilizes the aforementioned index values into the color table to look up the color specification information stored in the color table. In this manner the color value to be displayed at each pixel is ascertained by the graPHIGS type interface and placed into the frame buffer each display cycle.

Also shown in FIG. 7 are exemplary vector commands, such as "set_color (slot 250)", which allows a color in a particular slot in table 600 to be set to a user specified value; "draw_line (0,0,100,100)", which allows the user to specifying the endpoints of a line segment (in this case (0,0) and (100,100)) to be drawn by, for example, a graPHIGS type interface; and "draw_point (90 90)", which allows the user to specifying a point (in this case (90,90)) to be drawn. According to the illustrative GPG GIS system in which the invention is being described, vector type commands would be initially processed by the aforementioned graphics manager 402 (shown in FIG. 4), and then be processed by the aforementioned graPHIGS type interface which creates the line, point, etc., to be displayed on the display screen.

Having described a commercially available modeling system (in particular a GIS system) in which the invention may be practiced, with specific reference to exemplary sections of the Enabler Services portion 301 of GIS 300 where raster and vector data are managed for display purposes; attention will now be directed to how the invention may be applied to visibly distinguish raster and vector data images that are simultaneously visible on a display device.

Reference should now be made to FIG. 8 which depicts a hardware configuration which specifically supports an illustrative embodiment of the present invention. According to the illustrative embodiment of the invention, software included in the depicted color manager 801 (corresponding to color manager 406 from FIG. 4), is used, in the manner taught hereinafter, to modify color specification entries in the depicted color table 802, which may, for example, be structured like color table 600 shown in FIG. 6.

The system depicted in FIG. 8 includes the following components:

(1) a graphics manager 810, which may be realized by the graphics manager 402 referred to hereinabove (with reference to FIG. 4), available as part of the commercially available GPG GIS system;

(2) an image manager 811, which may be realized by the image manager 403 referred to hereinabove (with reference to FIG. 4), available as part of the commercially available GPG GIS system;

(3) the commercially available graPHIGS type interface, 812,, referred to hereinabove, which may, for example, be run on an IBM PS/2 computing system;

(4) the aforementioned color table 800, included as part of most commercially available color graphic display subsystems;

(5) the aforementioned color manager 801, included, for example, as part of the Enabler Services 301 portion of commercially available GIS systems, such as the GPG GIS described hereinbefore with reference to FIGS. 3–5.

(6) Frame buffer 815 and CRT 817, included as part of most commercially available color graphic display subsystems; and

(7) a utility package, such as the aforementioned Microsoft Windows version 3.1, (shown in FIG. 8 at 820), which allows a user to visualize control elements such as software generated slider bars, control knobs, etc., displayed on CRT 817.

The control elements generated by the user control utility (such as Windows), are represented in block 825 of FIG. 8; however, as those skilled in the art will readily appreciate, the actual images of the control element(s) are output to CRT 817 via the Windows/graPHIGS type interface, 350, depicted in FIG. 8. Also, those skilled in the art will recognize the ability to generate control elements for display purposes and to react to user inputs via these elements, could be resident in another utility, such as (for example) illustrative color manager 801, without departing from the scope or spirit of the present invention.

According to the invention, color table 800, color manager 801, a utility (such as Windows) shown at 820, and the control elements represented by 825, are the key components which can be placed in combination in existing graphics systems, without having to modify or add any hardware, to allow a user to visually separate raster and vector data images by modifying the color specifications stored for these data types in color table 800.

In FIG. 8, color table 800 is shown coupled to color manager 801 via link 851; color manager 801 is shown coupled to the exemplary Windows program (820) via link 852; and the utility at block 820 (e.g., Windows), is shown coupled to the control elements depicted in block 825 via link 853 (with the actual images being sent to CRT 817 via link 850 as explained hereinabove).

According to an illustrative embodiment of the invention, the Windows program (for example), using well known techniques, can be used to display a pair of software generated slider bars on the display screen. One of these bars may be arbitrarily assigned for the control of raster data, while the other bar is assigned for the control of vector data.

Assuming the bars are set at an initial position recognized by the Windows program; any movement by the user of a given bar in one direction may be used to signal that the user wishes to increase the intensity of the data type controlled by the particular slider bar; while movement in the opposite direction may be used to signal that the user wishes to decrease the intensity of the data type controlled by that same slider bar. Such an arrangement would allow for independent control of the brightness of the displayed data types.

FIG. 9 depicts how a slider bar (or bars) may be used, in accordance with one embodiment of the invention, to control the brightness of displayed data images. The example depicted in FIG. 9 shows the slider bar for controlling one data type (say raster data), in an initial start position as shown on the display image represented in block **901**. This image can, as indicated hereinabove, be generated and controlled using a utility such as Windows.

Should the user cause the slider bar to be offset, such as depicted in block **902** of FIG. **9**, a utility (such as the Windows utility shown at block **820** of FIG. **8**), could, calculate the offset of the bar from its normal position (as shown at block **903** of FIG. **9**). Once such an offset is calculated, the utility would inform color manager **801** (via link **852**) of any change and then color manager **801** would make all colors allocated to (controlled by) the slider bar, brighter or dimmer (as shown at blocks **904** and **905** of FIG. **9**, respectively), based on the user having offset the slider bar in a given direction. This can be accomplished, according to the invention, by adjusting all of the color table entries stored in color specification storage means (in which color table **800** is stored), by an adjustment factor.

The adjustment factor could be a fixed quantity, a variable dependent on the degree of offset of the slider bar from the normal position, etc. In any event, what is important is that all of the color table entries, for the data type under the control of a defined control element, be modified in response to the user control signal generated when, for example, a slider bar is moved.

An alternative embodiment of the invention contemplates only a single slider bar or other control element being presented to the user, with the color table entries associated with one of the data types (such as vector data) all being adjusted in one direction (positively or negatively depending on the direction or movement of the control element); while all of the color table entries associated with the other data type are adjusted in the opposite direction for the same movement of the control element. Many variations on the amount of adjustment, whether adjustments are made independently, dependently, etc., can be envisioned by those skilled in the art without departing from the scope or spirit of the invention which focuses on modifying (adjusting) all of the color specification entries assigned to a given data type, upon recognition of a control signal generated by a user (or evenn program generated) request.

The required adjusting of color table entries can, according to one embodiment of the invention, be implemented by the aforementioned color manager **801** (an example of color specification modification means), utilizing a simple increment/decrement scheme.

In response to a first signal generated by a given control element (for example, when a slider bar as depicted in FIG. **9** (at **902**) is moved to the right), all of the color specification entries under the control of that slider bar could be incremented by a fixed amount; a second control signal generated when the bar is moved in the opposite direction, could be used to cause all of the color specification entries under the control of that slider bar to be decremented, etc. A corresponding third and fourth signal could be used for a second slider bar controlling color table entries associated with the other data type.

The aforementioned increment/decrement scheme (whether fixed adjustment factors or variable adjustment factors are used), may be easily implemented by those skilled in the art using simple hardware control logic or, according to the preferred embodiment of the invention, software. All that need be done (in one example) is to recognize the presence of an input brightness control signal (e.g., by the software checking a status bit or counter set or modified by the presence of the control signal); and then, for example, incrementing each color table entry for the affected data type by an adjustment factor associated with the control signal whenever such signal is present.

Further reference should be made to FIG. **8** which shows all the elements of an exemplary system for supporting the invention, and how these elements cooperate.

As indicated hereinabove, graphics manager **810** and image manager **811**, both found in commercially available GIS systems, may be used to communicate with a commercially available graPHIGS type interface, to process both raster and vector commands (such as those depicted in FIG. 7). Manager **810** and **811** are shown coupled to graPHIGS type interface **812**, via links **830** and **831** respectively.

As indicated hereinabove, a graPHIGS type interface **812** may be run on an IBM PS/2 system, and is used to place the image to be displayed for the upcoming frame into frame buffer **815** (part of the display subsystem).

Since the graPHIGS type interface is continuously executing the display program (set of display commands) stored in the display list buffer referred to hereinabove (not shown in FIG. **8**, but part of the display subsystem); if a change occurs in color table values, these changes are reflected by graPHIGS type interface input to the frame buffer (as explaoned hereinabove) during the frame following the frame in which the changes are made to the color table (by, for example, color manager **801** in the manner described hereinbefore), and images with their brightness having been varied are displayed on CRT **817** during the next display frame.

This brightness modification of data images appearing on CRT **817** appears to be happening in real time to a user manipulating the control elements (block **825** of FIG. **8**) and viewing CRT **817**.

This is because each display cycle, with the graPHIGS type interface executing the commands in the display list buffer, the interface indexes into color table **800** to determine color specification values, via link **845** shown in FIG. **8**. If the values in the color table associated with one or more data types has changed; then the new color (a brighter one, or dimmer one for each pixel illuminated with the color specified by a modified color table entry), is output to frame buffer **815** (by graPHIGS type interface **812** via link **846**); for display on CRT **817** (via link **847**).

Thus, according to one embodiment of the invention, color table entries may be modified by user action with the result that the user may be able to distinguish data type images (such as raster data images from vector data images), based on the brightness of the images appearing on CRT **817**.

Finally, reference should be made to FIG. **10** which depicts, in the form of a summary flow chart, the user interaction and resulting process steps contemplated by a preferred embodiment of the invention.

In particular, FIG. **10** depicts an exemplary GIS environment (shown at block **1001**), under which a user may input

vector and raster commands as shown at blocks **1010** and **1020** respectively.

In either case, a color manager is presumed to allocate a fixed number of slots in a color table for vector data and a fixed number of slots for raster data as shown at blocks **1011** and **1021**, respectively. Those skilled in the art will recognize that some systems may even allow for a variable number of slots to be used for different data type assignments. In these situations, any software or logic developed to modify all of the data under the control of a given control element, would have to be informed of any changes in slot assignments between data types so that the adjustment factor(s) used in response to input control signal(s) would be used to modify the appropriate color table entries.

FIG. **10** goes on to show a display of overlapping vector and raster data on a screen taking place at block **1025**.

Block **1026** of FIG. **10** indicates that a color manager (or other utility, such as the aforementioned Windows utility in combination with a preexisting color manager), display slider bars on the screen. According to the illustrative embodiment of the invention being described, one of the bars is for the control of the brightness of raster data; while the other bar is for the control of the brightness of vector data.

The user is shown to adjust the slider bars to suit viewing needs, at block **1027** of FIG. **10**.

Finally, blocks **1028** and **1029** of FIG. **10** indicate that if the user wishes to concentrate on vector data, the bar used to control vector data is positioned to make vector data brighter and the bar used to control raster data is positioned to make such data dimmer (block **1028**); while the opposite scenario is presented at block **1029**. Obviously, the user may manipulate one of the bars or both to suit viewing needs.

What has been described in detail hereinabove are methods and apparatus meeting all of the aforestated objectives. As previously indicated, those skilled in the art will recognize that the foregoing description has been presented for the sake of illustration and description only. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching.

The embodiments and examples set forth herein were presented in order to best explain the principles of the instant invention and its practical application to thereby enable others skilled in the art to best utilize the instant invention in various embodiments and with various modifications as are suited to the particular use contemplated.

It is, therefore, to be understood that the claims appended hereto are intended to cover all such modifications and variations which fall within the true scope and spirit of the invention.

What is claimed is:

1. A method for enabling images on a display screen generated from raster data to be visually distinguished from images on the same screen generated from vector data, in a modeling system that includes a color table partitioned into a first set of color table entries each dedicated exclusively for specifying the color of raster data and a mutually exclusive second set of color table entries each dedicated exclusively for specifying the color of vector data, comprising the steps of:

(a) controlling the brightness of raster data images on said screen directly in response to a first control signal, generated in real time by a first control means, which causes all of the entries located in said first set of color table entries to be incrementally modified simultaneously to thereby adjust the brightness of all raster data images displayed during a given display cycle, via a single user operation in which color table entry modification is transparent to the user; and

(b) controlling the brightness of vector data images on said screen directly in response to a second control signal, generated in real time by a second control means, which causes all of the entries located in said second set of color table entries to be incrementally modified simultaneously to thereby adjust the brightness of all vector data images displayed during a given display cycle via a single user operation in which color table entry modification is transparent to the user,

whereby the user is able to view an animated color differentiation between vector and raster data as the user adjusts vector and/or raster data image brightness.

2. A method as set forth in claim **1** wherein said step of controlling the brightness of raster data images in response to said first control signal further comprises the step of modifying all color table entries specifying the color of raster data in said system by a first adjustment factor.

3. A method as set forth in claim **2** wherein said first adjustment factor is added to the red, green and blue components of each color table entry specifying the color of raster data in said system to increase the brightness of raster data.

4. A method as set forth in claim **2** wherein said first adjustment factor is subtracted from the red, green and blue components of each color table entry specifying the color of raster data in said system to decrease the brightness of raster data.

5. A method as set forth in claim **2** wherein said first adjustment factor is a variable quantity.

6. A method as set forth in claim **2** wherein said first adjustment factor is a fixed quantity.

7. A method as set forth in claim **1** wherein said step of controlling the brightness of vector data images in response to said second control signal further comprises the step of modifying all color table entries specifying the color of vector data in said system by a second adjustment factor.

8. A method as set forth in claim **7** wherein said second adjustment factor is added to the red, green and blue components of each color table entry specifying the color of vector data in said system to increase the brightness of vector data.

9. A method as set forth in claim **7** wherein said second adjustment factor is subtracted from the red, green and blue components of each color table entry specifying the color of vector data in said system to decrease the brightness of vector data.

10. A method as set forth in claim **7** wherein said second adjustment factor is a variable quantity.

11. A method as set forth in claim **7** wherein said second adjustment factor is a fixed quantity.

12. A method for distinguishing raster data display images from vector data display images in a modeling system in which both raster data and vector data display images are simultaneously viewable on the same display window, wherein said system includes a cathode ray tube (CRT) having a defined display window, a color table for storing color specifications assigned to data to be displayed on said CRT, wherein said color table is partitioned into a first set of color table entries each dedicated exclusively for specifying the color intensity of raster data and a mutually exclusive second set of color table entries each dedicated exclusively for specifying the color intensity of vector data, a color manager for modifying color table entries in response to user input control signals, control means for inputting said con-

trol signals, a graphics manager for processing vector commands, and an image manager for processing raster commands, comprising the steps of:

(a) predefining said first set of color table entries and predefining second set of color table entries;

(b) increasing simultaneously in real time the color intensity of all of the entries in said first set of color table entries via said color manager directly in response to a first control signal input to said color manager by the user via said control means to thereby increase the brightness of all raster data images displayed during a given display cycle, via a single user operation in which color table entry modification is transparent to the user;

(c) decreasing simultaneously in real time the color intensity of all of the entries in said first set of color table entries via said color manager directly in response to a first control signal input to said color manager by the user via said control means to thereby decrease the brightness of all raster data images displayed during a given display cycle, via a single user operation in which color table entry modification is transparent to the user;

(d) increasing simultaneously in real time the color intensity of all of the entries in said second set of color table entries via said color manager directly in response to a second control signal input to said color manager by the user via said control means to thereby increase the brightness of all vector data images displayed during a given display cycle, via a single user operation in which color table entry modification is transparent to the user;

(e) decreasing simultaneously in real time the color intensity of all of the entries in said second set of color table entries via said color manager directly in response to a second control signal input to said color manager by the user via said control means to thereby decrease the brightness of all vector data images displayed during a given display cycle, via a single user operation in which color table entry modification is transparent to the user,

whereby the user is able to view an animated color differentiation between vector and raster data as the user adjusts vector and/or raster data image brightness.

13. A method as set forth in claim 12 further comprising the steps of:

(a) periodically refreshing said CRT to display vector and raster images corresponding to the vector and raster commands processed by said graphics manager and image manager; and

(b) updating said display to adjust the brightness of display images starting with a refresh cycle following the color intensity in said color table having been modified for at least one data type, thereby allowing a user to distinguish between vector data images and raster data images being displayed.

14. A method for selectively controlling the brightness of raster data images and vector data images on a display screen in a computer graphics system that includes a color table partitioned into a first set of color table entries each dedicated exclusively for specifying the color of raster data and a mutually exclusive second set of color table entries each dedicated exclusively for specifying the color of vector data, comprising the steps of:

(a) inputting a user request to said system to change the brightness of either said raster data, said vector data or both said raster data and said vector data being displayed on said screen in real time; and

(b) simultaneously incrementally modifying all color table entries in said first set of color table entries whenever the input user request is to change the brightness of raster data, simultaneously incrementally modifying all color table entries in said second set of color table entries whenever the input user request is to change the brightness of vector data and simultaneously incrementally modifying all color table entries in both said first and second set of color table entries whenever the input user request is to change the brightness of both raster and vector data, to thereby adjust the brightness of data images displayed during a given display cycle enabling the user to view an animated color differentiation between vector and raster data as the user adjusts vector and/or raster data image brightness.

15. A method as set forth in claim 14 further comprising the steps of:

(a) generating a first control signal in response to a user request to modify the brightness of said raster data image; and

(b) generating a second control signal in response to a user request to modify the brightness of said vector data image.

16. A method as set forth in claim 15 wherein said step of modifying further comprises the step of adjusting the brightness of raster data images in response to said first control signal by modifying all color table entries specifying the color of raster data in said system by a first brightness adjustment factor.

17. A method as set forth in claim 16 wherein said first brightness adjustment factor is added to the red, green and blue components of each color table entry specifying the color of raster data in said system to increase the brightness of raster data.

18. A method as set forth in claim 16 wherein said first brightness adjustment factor is subtracted from the red, green and blue components of each color table entry specifying the color of raster data in said system to decrease the brightness of raster data.

19. A method as set forth in claim 16 wherein said first adjustment factor is a variable quantity.

20. A method as set forth in claim 16 wherein said first adjustment factor is a fixed quantity.

21. A method as set forth in claim 15 wherein said step of modifying further comprises the step of adjusting the brightness of vector data images in response to said second control signal by modifying all color table entries specifying the color of vector data in said system by a second brightness adjustment factor.

22. A method as set forth in claim 21 wherein said second brightness adjustment factor is added to the red, green and blue components of each color table entry specifying the color of vector data in said system to increase the brightness of vector data.

23. A method as set forth in claim 21 wherein said second brightness adjustment factor is subtracted from the red, green and blue components of each color table entry specifying the color of vector data in said system to decrease the brightness of vector data.

24. A method as set forth in claim 21 wherein said second brightness adjustment factor is a variable quantity.

25. A method as set forth in claim 21 wherein said second brightness adjustment factor is a fixed quantity.

26. Apparatus for distinguishing raster data display images from vector data display images in a computer graphics system in which both raster data and vector data display images are simultaneously viewable on the same display window, wherein said system includes a cathode ray

tube (CRT) having a defined display window, a vector command processor, a raster command processor, and further wherein a first set of color intensity specifications are defined for raster data and a second mutually exclusive set of color intensity specifications are defined for vector data, comprising:

(a) partitioned color specification storage means, for storing said first and second mutually exclusive sets of color specifications assigned to data to be displayed on said CRT, wherein said color specification storage means is initialized with said first and second mutually exclusive sets of color specifications;

(b) user input control means for inputting a user request to said system, in the form of at least one brightness control signal, to change the brightness of either said raster data, said vector data or both said raster data and said vector data displayed in said display window in real time; and

(c) color specification modification means, for modifying color specification storage means entries in response to said at least one brightness control signal, operative to incrementally modify all the entries in said first set of color specifications stored in said color specification storage means simultaneously in real time whenever said at least one control signal indicates that the brightness of raster data is to be modified, and operative to incrementally modify all the entries in said second set of color specifications stored in said color specification storage means simultaneously in real time whenever said at least one control signal indicates that the brightness of vector data is to be modified, to thereby adjust the brightness of data images displayed during a given display cycle enabling the user to view an animated color differentiation between vector and raster data as the user adjusts vector and/or raster data image brightness.

27. Apparatus as set forth in claim 26 wherein said color specification modification means further comprises means for adding a brightness adjustment factor to the red, green and blue components of each color specification storage means entry in said first set of color specification entries to increase the brightness of raster data.

28. Apparatus as set forth in claim 26 wherein said color specification modification means further comprises means for subtracting a brightness adjustment factor from the red, green and blue components of each color specification storage means entry in said first set of color specification entries to decrease the brightness of raster data.

29. Apparatus as set forth in claim 26 wherein said color specification modification means further comprises means for adding a brightness adjustment factor to the red, green and blue components of each color specification storage means entry in said second set of color specification entries to increase the brightness of vector data.

30. Apparatus as set forth in claim 26 wherein said color specification modification means further comprises means for subtracting a brightness adjustment factor from the red, green and blue components of each color specification storage means entry in said second set of color specification entries to decrease the brightness of vector data.

31. Apparatus as set forth in claim 26 wherein said color specification modification means is operative to modify said color specification storage means entries by a brightness adjustment factor that is a variable quantity.

32. A method as set forth in claim 26 wherein said color specification modification means is operative to modify said color specification storage means entries by a brightness adjustment factor that is a fixed quantity.

33. Apparatus as set forth in claim 26 wherein said user input control means comprises a visible control appearing in the graphic field of view in said display window.

34. Apparatus as set forth in claim 33 wherein said visible control appearing in said display window is a software generated slider bar.

35. Apparatus as set forth in claim 33 wherein said visible control is a software generated dial widget.

36. Apparatus as set forth in claim 26 further comprising:

(a) means for periodically refreshing said CRT to display vector and raster images corresponding to vector and raster commands processed by said vector command processor and said raster command processor; and

(b) means for updating said display to adjust the brightness of display images starting with a refresh cycle following the time period during which color intensity in said color specification storage means is modified.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,499,325

DATED : Mar. 12, 1996

INVENTOR(S) : Robert F. Dugan, Jr.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Column 12, line 55 The following paragraph should be inserted after line 55:

-- By way of further contrast, the color table contemplated by the present invention (illustrated by way of example with reference to FIG. 6), is partitioned into mutually exclusive sets of raster and vector. In particular, FIG. 6 illustrates an example of the partitioned color table structure contemplated by the invention; one in which a preponderance of the entries are associated with raster data color assignments (for example, slots 0-239 as shown in table 600), with the remaining slots being used for vector data color assignments (for example, slots 240-255 as shown in table 600.--.

Signed and Sealed this

Twenty-fourth Day of September, 1996

Attest:

Bruce Lehman

BRUCE LEHMAN

Attesting Officer *Commissioner of Patents and Trademarks*

US006289278B1

(12) **United States Patent**
Endo et al.

(10) **Patent No.: US 6,289,278 B1**
(45) **Date of Patent: Sep. 11, 2001**

(54) **VEHICLE POSITION INFORMATION DISPLAYING APPARATUS AND METHOD**

(75) Inventors: **Yoshinori Endo**; **Toshimichi Minowa**, both of Mito; **Kozo Nakamura**, Hitachiota; **Hiroshi Takenaga**, Ibaraki-ken; **Hiroto Morizane**; **Tokuji Yoshikawa**, both of Hitachi; **Mitsuru Nakamura**, Hitachinaka, all of (JP)

(73) Assignee: **Hitachi, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/258,153**

(22) Filed: **Feb. 26, 1999**

(30) **Foreign Application Priority Data**

Feb. 27, 1998 (JP) 10-046817

(51) **Int. Cl.**[7] **G06F 165/00**

(52) **U.S. Cl.** **701/208**; 701/96; 701/211; 701/212; 701/214; 340/988; 340/990; 342/357.01; 342/357.13

(58) **Field of Search** 701/207, 208, 701/211, 212, 214, 216, 96; 340/988, 990, 995; 342/357.01, 357.02, 357.13

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,729,109 * 3/1998 Kaneko 701/209
5,884,217 * 3/1999 Koyanagi 701/208
6,035,253 * 3/2000 Hayashi et al. 701/211

FOREIGN PATENT DOCUMENTS

0 590 588 4/1994 (EP) .
58-27678 2/1983 (JP) .
58-203524 11/1983 (JP) .
9-166452 6/1997 (JP) .
WO 97/43600 11/1997 (WO) .

* cited by examiner

Primary Examiner—William A. Cuchlinski, Jr.
Assistant Examiner—Gertrude Arthur
(74) *Attorney, Agent, or Firm*—Crowell & Moring, L.L.P.

(57) **ABSTRACT**

A vehicle position information displaying apparatus and method are disclosed in which position information of a preceding vehicle is displayed in a manner superimposed on the form of a road under running of a user's vehicle generated from map information. The apparatus includes a present position detecting unit for detecting the present position of the user's vehicle, a running road selecting unit for selecting a road under running of the user's vehicle from the present position of the user's vehicle, an other vehicle detecting unit for detecting a distance to another vehicle and the azimuth of the other vehicle, an other vehicle position determining unit for determining the position of the other vehicle, and an other vehicle position displaying unit for developing the running road to a plane view or birds-eye view and displaying position information of the user's vehicle and the other vehicle in a manner superimposed on the developed running road.

27 Claims, 18 Drawing Sheets

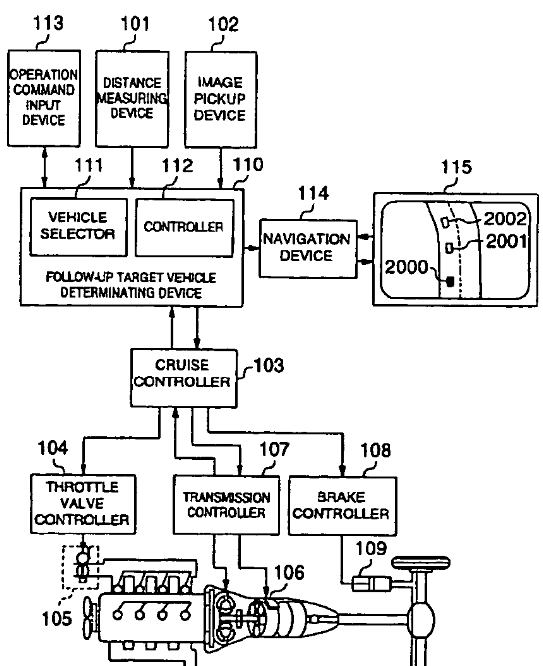


FIG. 1

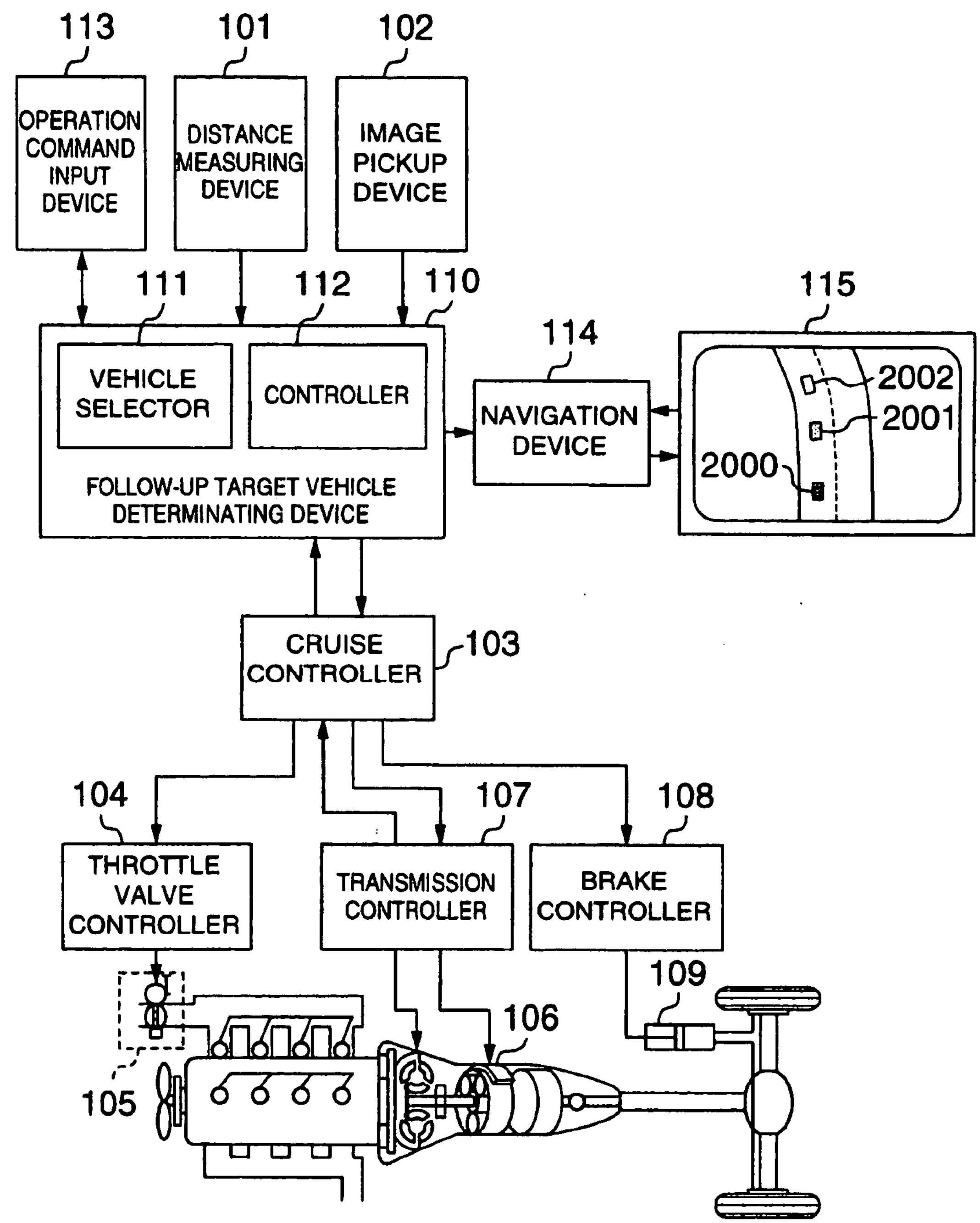

113
101
102
OPERATION COMMAND INPUT DEVICE
DISTANCE MEASURING DEVICE
IMAGE PICKUP DEVICE
111
112
110
115
114
VEHICLE SELECTOR
CONTROLLER
FOLLOW-UP TARGET VEHICLE DETERMINATING DEVICE
NAVIGATION DEVICE
2002
2001
2000
CRUISE CONTROLLER
103
104
107
108
THROTTLE VALVE CONTROLLER
TRANSMISSION CONTROLLER
BRAKE CONTROLLER
109
106
105

FIG. 2

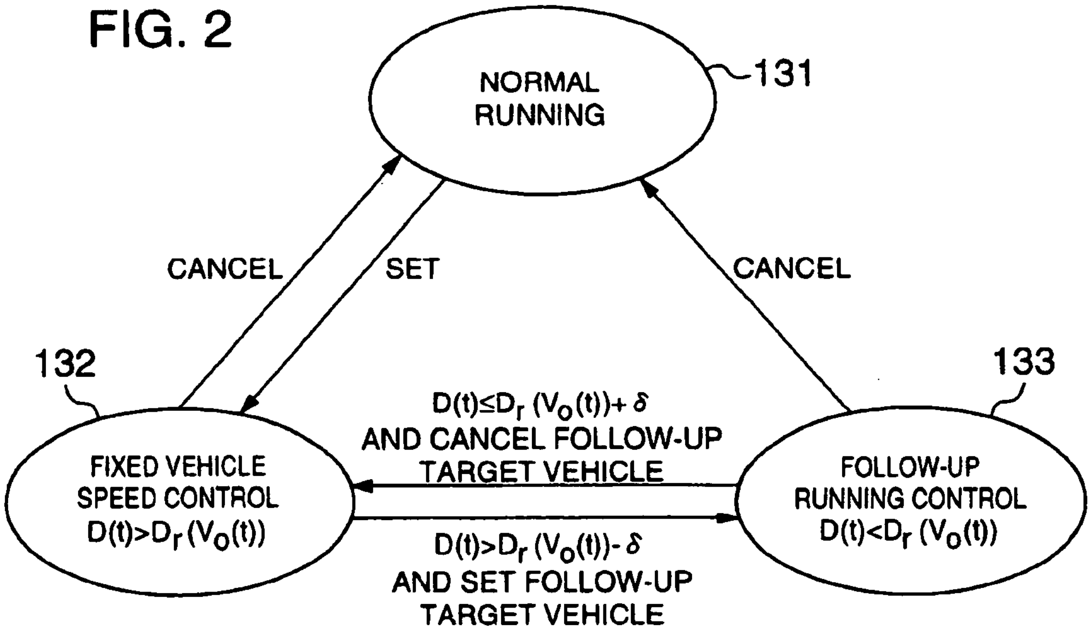

NORMAL RUNNING
131
CANCEL
SET
CANCEL
132
133
D(t)≤Dr (Vo(t))+ δ
AND CANCEL FOLLOW-UP
TARGET VEHICLE
FIXED VEHICLE
SPEED CONTROL
D(t)>Dr (Vo(t))
FOLLOW-UP
RUNNING CONTROL
D(t)<Dr (Vo(t))
D(t)>Dr (Vo(t))- δ
AND SET FOLLOW-UP
TARGET VEHICLE

FIG. 3

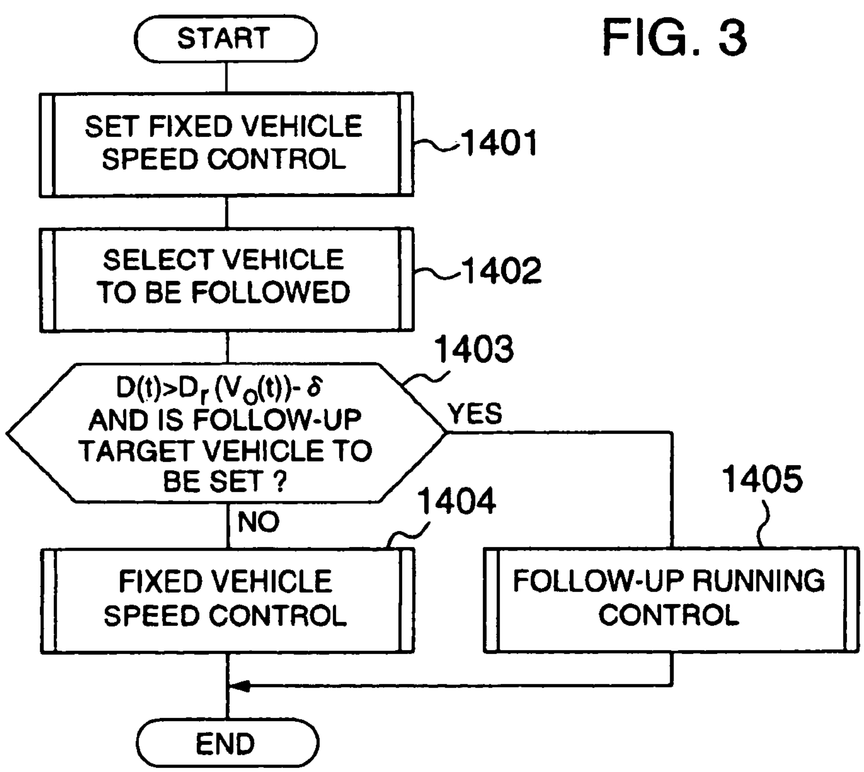

START
SET FIXED VEHICLE SPEED CONTROL
1401
SELECT VEHICLE TO BE FOLLOWED
1402
1403
D(t)>Dr (Vo(t))- δ AND IS FOLLOW-UP TARGET VEHICLE TO BE SET ?
YES
NO
1404
1405
FIXED VEHICLE SPEED CONTROL
FOLLOW-UP RUNNING CONTROL
END

FIG. 4

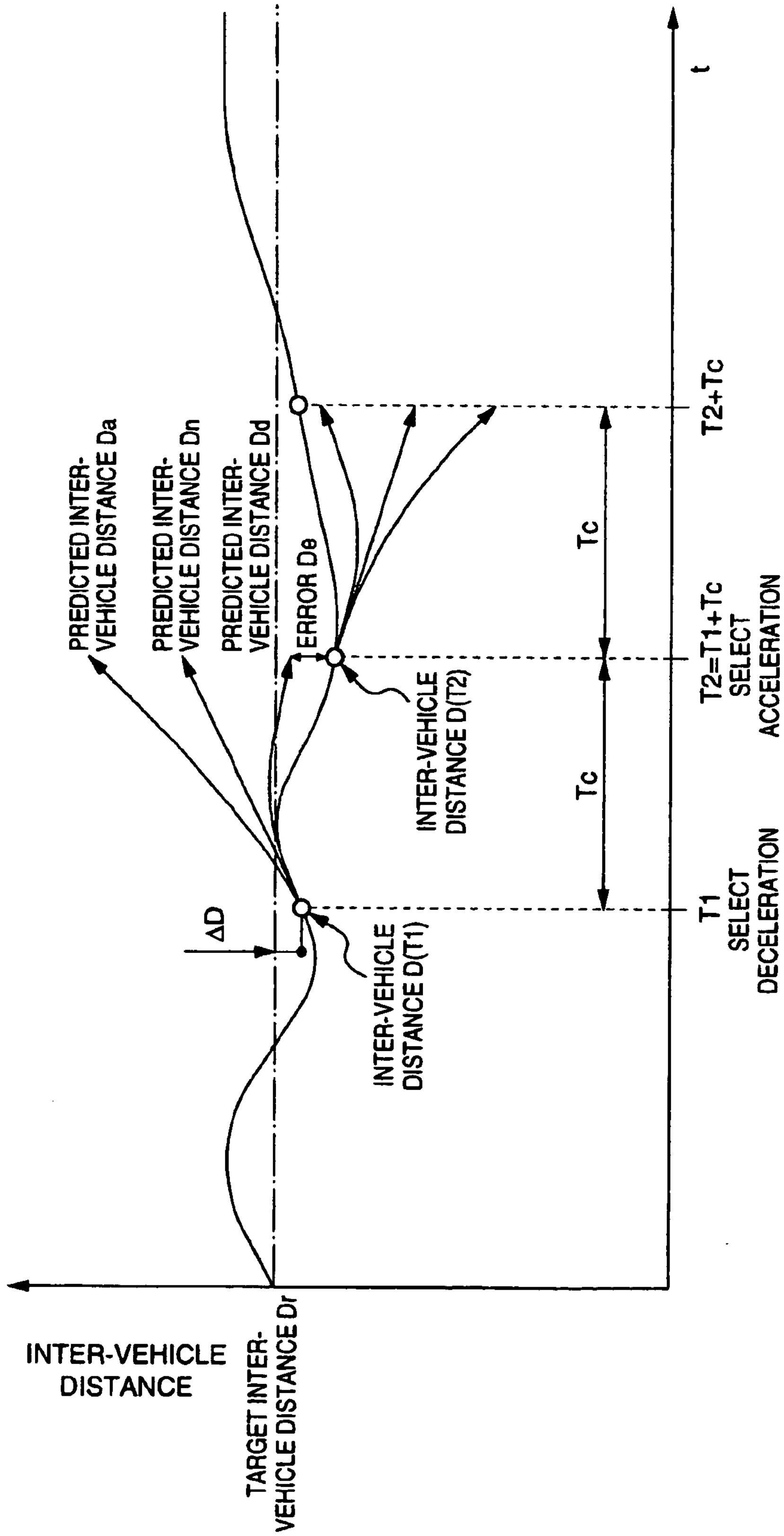

INTER-VEHICLE DISTANCE
TARGET INTER-VEHICLE DISTANCE Dr
t
PREDICTED INTER-VEHICLE DISTANCE Da
PREDICTED INTER-VEHICLE DISTANCE Dn
PREDICTED INTER-VEHICLE DISTANCE Dd
ERROR De
ΔD
INTER-VEHICLE DISTANCE D(T1)
INTER-VEHICLE DISTANCE D(T2)
Tc
Tc
T1 SELECT DECELERATION
T2=T1+Tc SELECT ACCELERATION
T2+Tc

FIG. 5

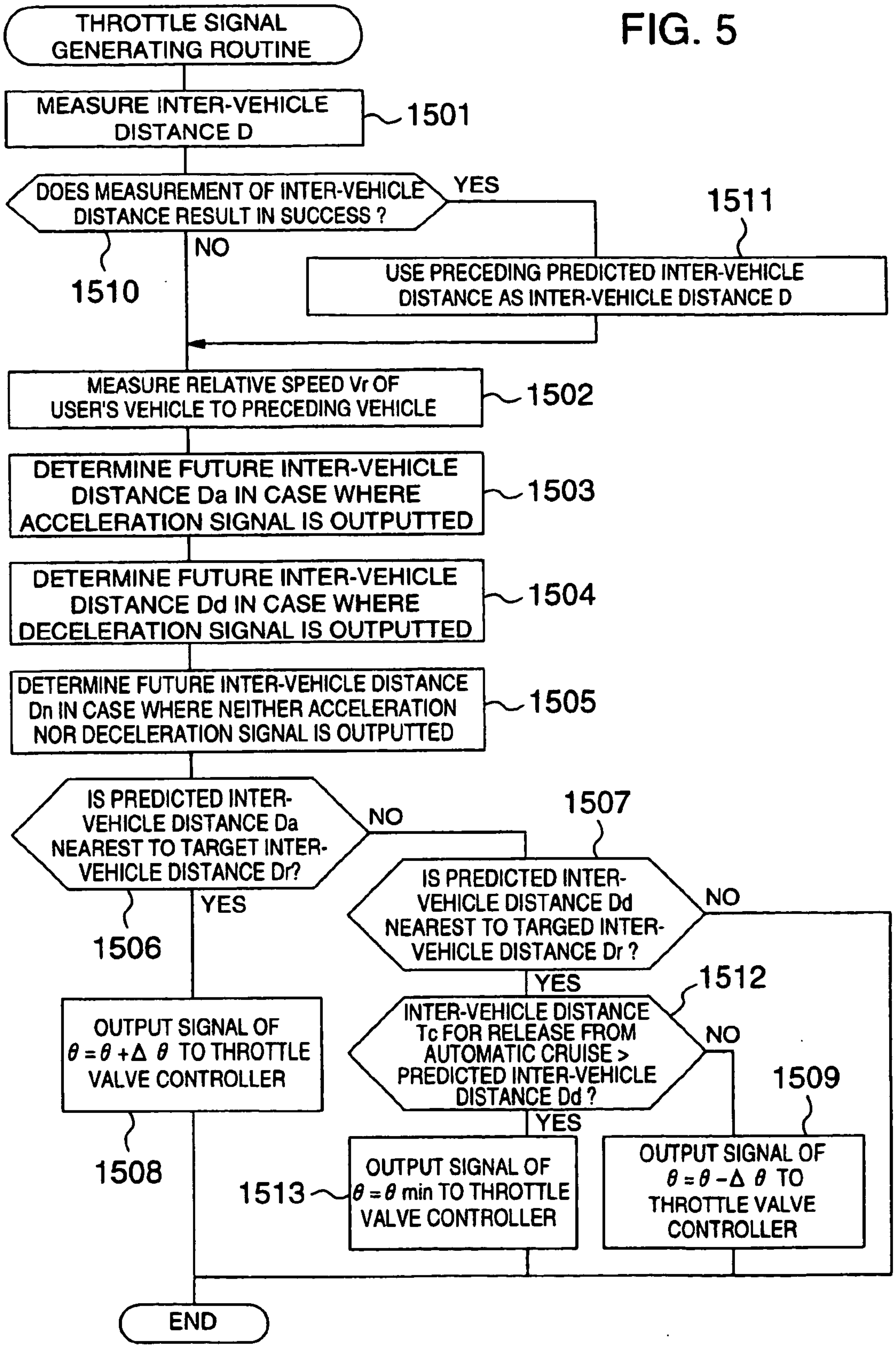

THROTTLE SIGNAL GENERATING ROUTINE
MEASURE INTER-VEHICLE DISTANCE D
1501
DOES MEASUREMENT OF INTER-VEHICLE DISTANCE RESULT IN SUCCESS ?
YES
NO
1510
1511
USE PRECEDING PREDICTED INTER-VEHICLE DISTANCE AS INTER-VEHICLE DISTANCE D
MEASURE RELATIVE SPEED Vr OF USER'S VEHICLE TO PRECEDING VEHICLE
1502
DETERMINE FUTURE INTER-VEHICLE DISTANCE Da IN CASE WHERE ACCELERATION SIGNAL IS OUTPUTTED
1503
DETERMINE FUTURE INTER-VEHICLE DISTANCE Dd IN CASE WHERE DECELERATION SIGNAL IS OUTPUTTED
1504
DETERMINE FUTURE INTER-VEHICLE DISTANCE Dn IN CASE WHERE NEITHER ACCELERATION NOR DECELERATION SIGNAL IS OUTPUTTED
1505
IS PREDICTED INTER-VEHICLE DISTANCE Da NEAREST TO TARGET INTER-VEHICLE DISTANCE Dr?
NO
YES
1506
1507
IS PREDICTED INTER-VEHICLE DISTANCE Dd NEAREST TO TARGED INTER-VEHICLE DISTANCE Dr ?
NO
YES
1512
INTER-VEHICLE DISTANCE Tc FOR RELEASE FROM AUTOMATIC CRUISE > PREDICTED INTER-VEHICLE DISTANCE Dd ?
NO
YES
OUTPUT SIGNAL OF θ=θ+Δθ TO THROTTLE VALVE CONTROLLER
1508
1513
OUTPUT SIGNAL OF θ=θ min TO THROTTLE VALVE CONTROLLER
1509
OUTPUT SIGNAL OF θ=θ−Δθ TO THROTTLE VALVE CONTROLLER
END

FIG. 6

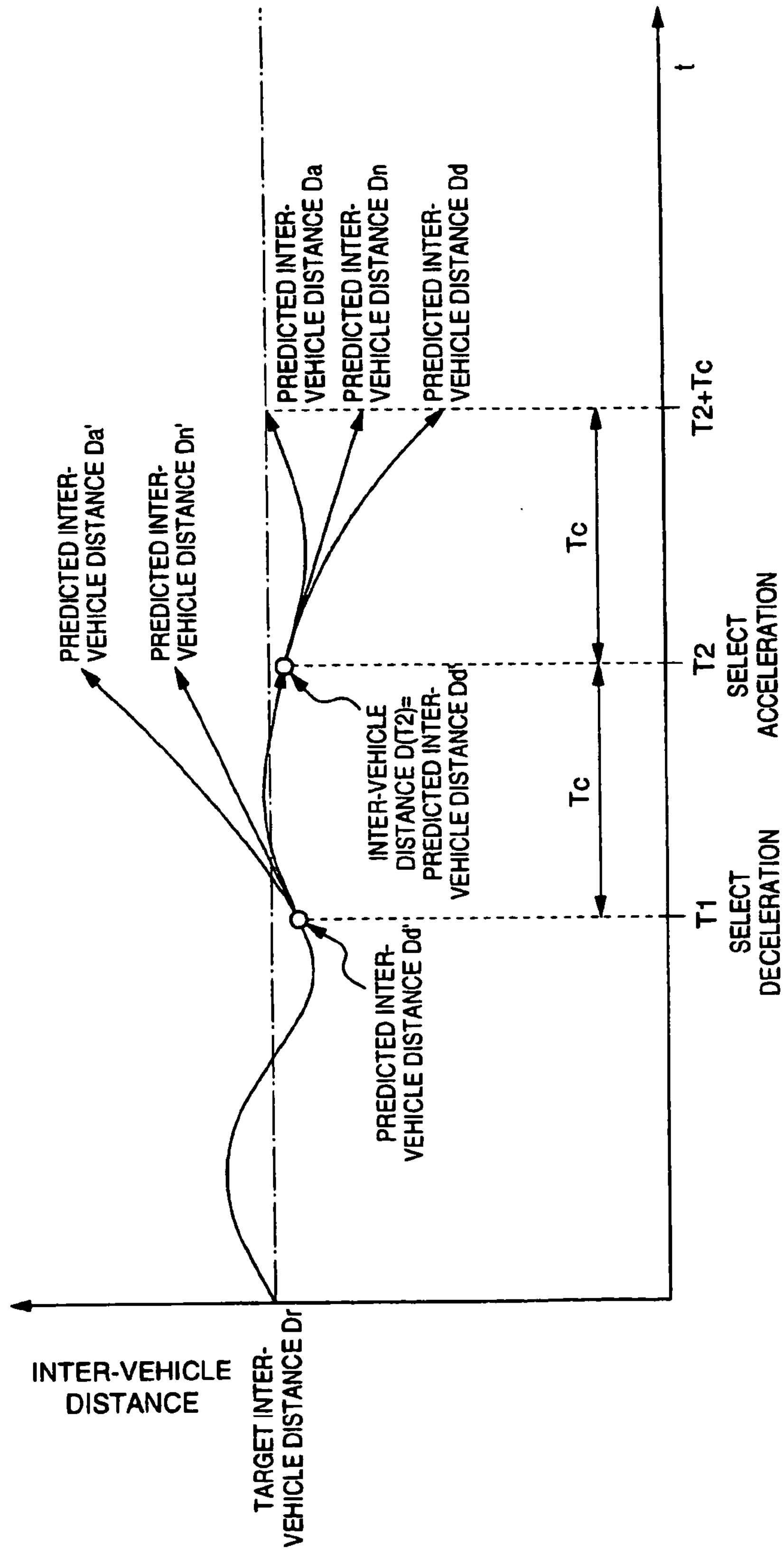

INTER-VEHICLE DISTANCE
TARGET INTER-VEHICLE DISTANCE Dr
PREDICTED INTER-VEHICLE DISTANCE Da'
PREDICTED INTER-VEHICLE DISTANCE Dn'
PREDICTED INTER-VEHICLE DISTANCE Da
PREDICTED INTER-VEHICLE DISTANCE Dn
PREDICTED INTER-VEHICLE DISTANCE Dd
PREDICTED INTER-VEHICLE DISTANCE Dd'
INTER-VEHICLE DISTANCE D(T2)= PREDICTED INTER-VEHICLE DISTANCE Dd'
Tc
Tc
T1
SELECT DECELERATION
T2
SELECT ACCELERATION
T2+Tc
t

FIG. 7

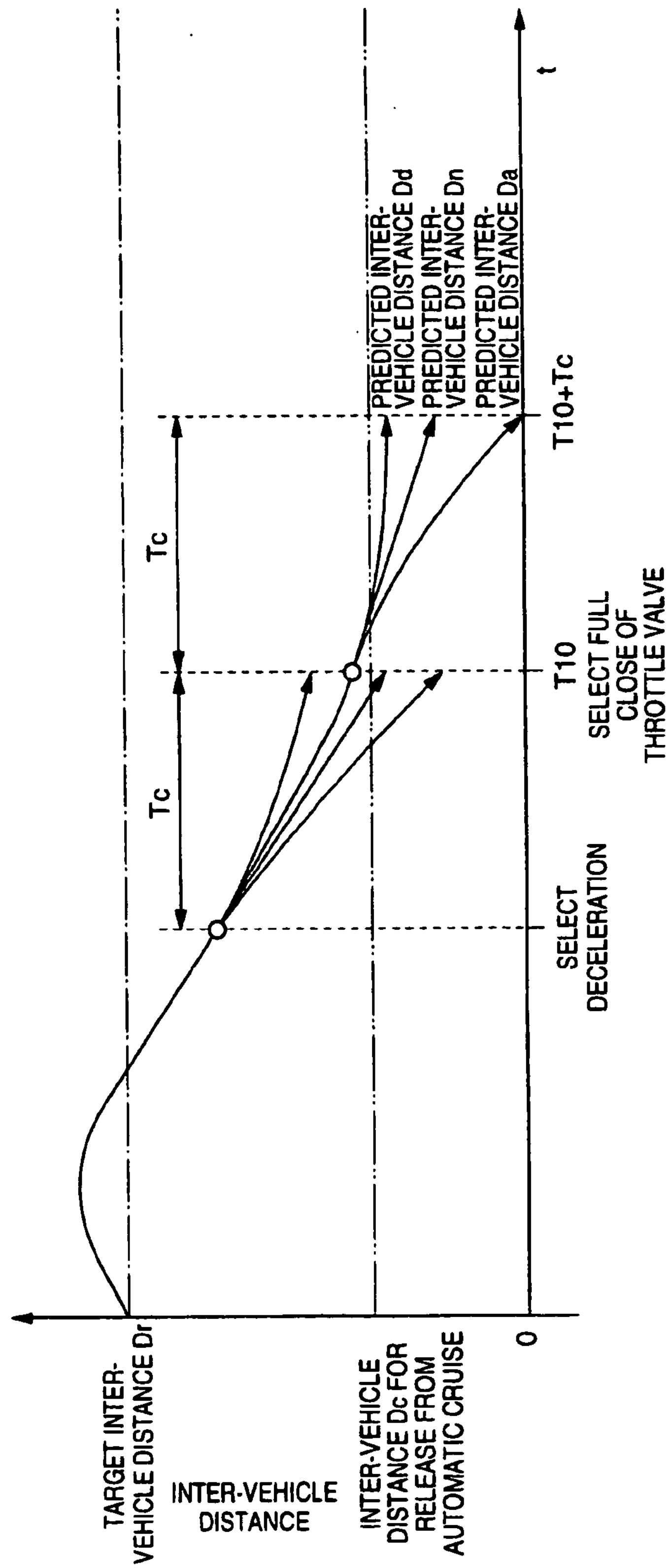

TARGET INTER-VEHICLE DISTANCE Dr
INTER-VEHICLE DISTANCE
INTER-VEHICLE DISTANCE Dc FOR RELEASE FROM AUTOMATIC CRUISE
0
Tc
Tc
PREDICTED INTER-VEHICLE DISTANCE Dd
PREDICTED INTER-VEHICLE DISTANCE Dn
PREDICTED INTER-VEHICLE DISTANCE Da
SELECT DECELERATION
T10
SELECT FULL CLOSE OF THROTTLE VALVE
T10+Tc
t

FIG. 8

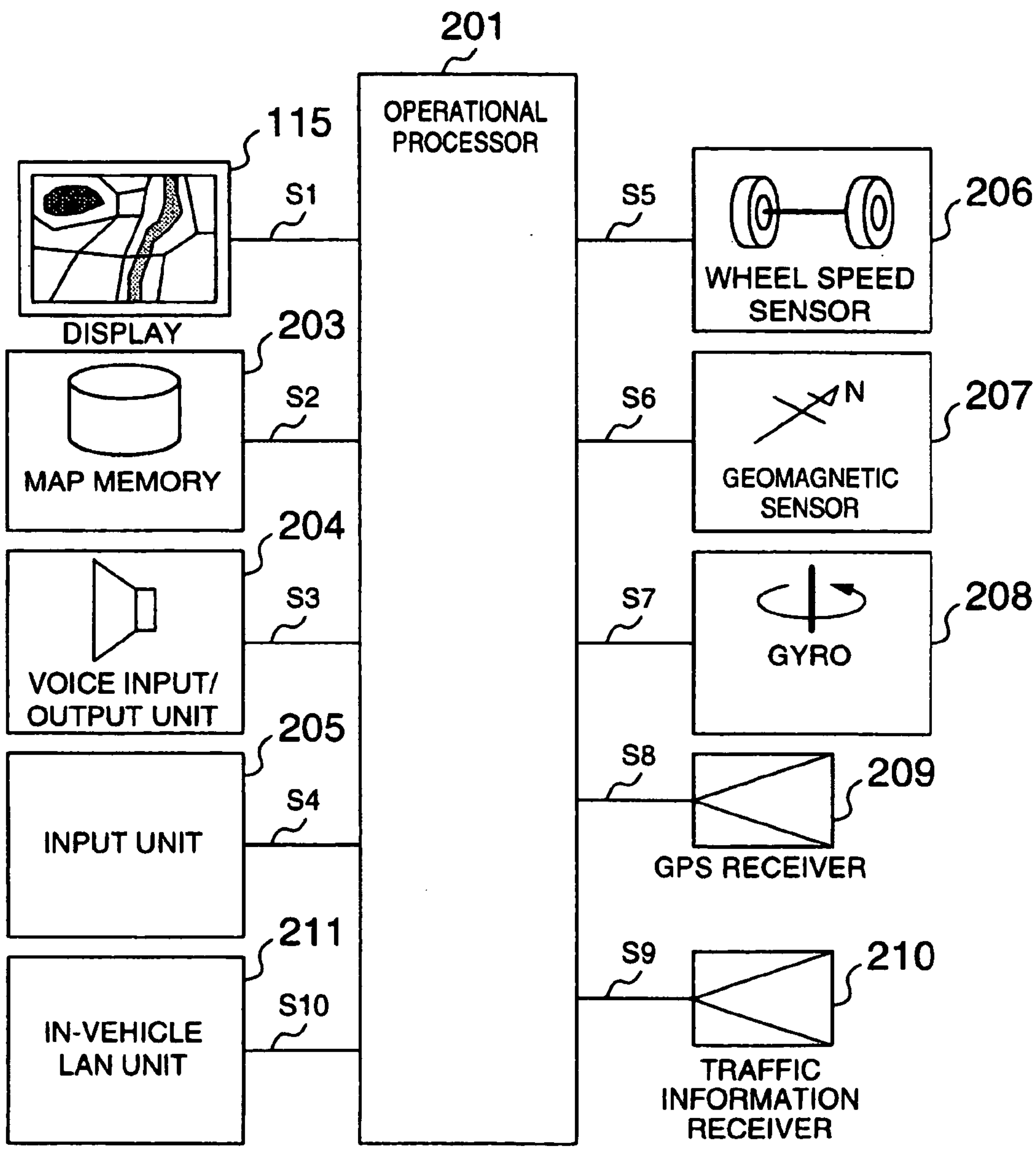

201
OPERATIONAL PROCESSOR
115
S1
DISPLAY
203
S2
MAP MEMORY
204
S3
VOICE INPUT/ OUTPUT UNIT
205
S4
INPUT UNIT
211
S10
IN-VEHICLE LAN UNIT
S5
WHEEL SPEED SENSOR
206
S6
N
GEOMAGNETIC SENSOR
207
S7
GYRO
208
S8
209
GPS RECEIVER
S9
210
TRAFFIC INFORMATION RECEIVER

FIG. 9

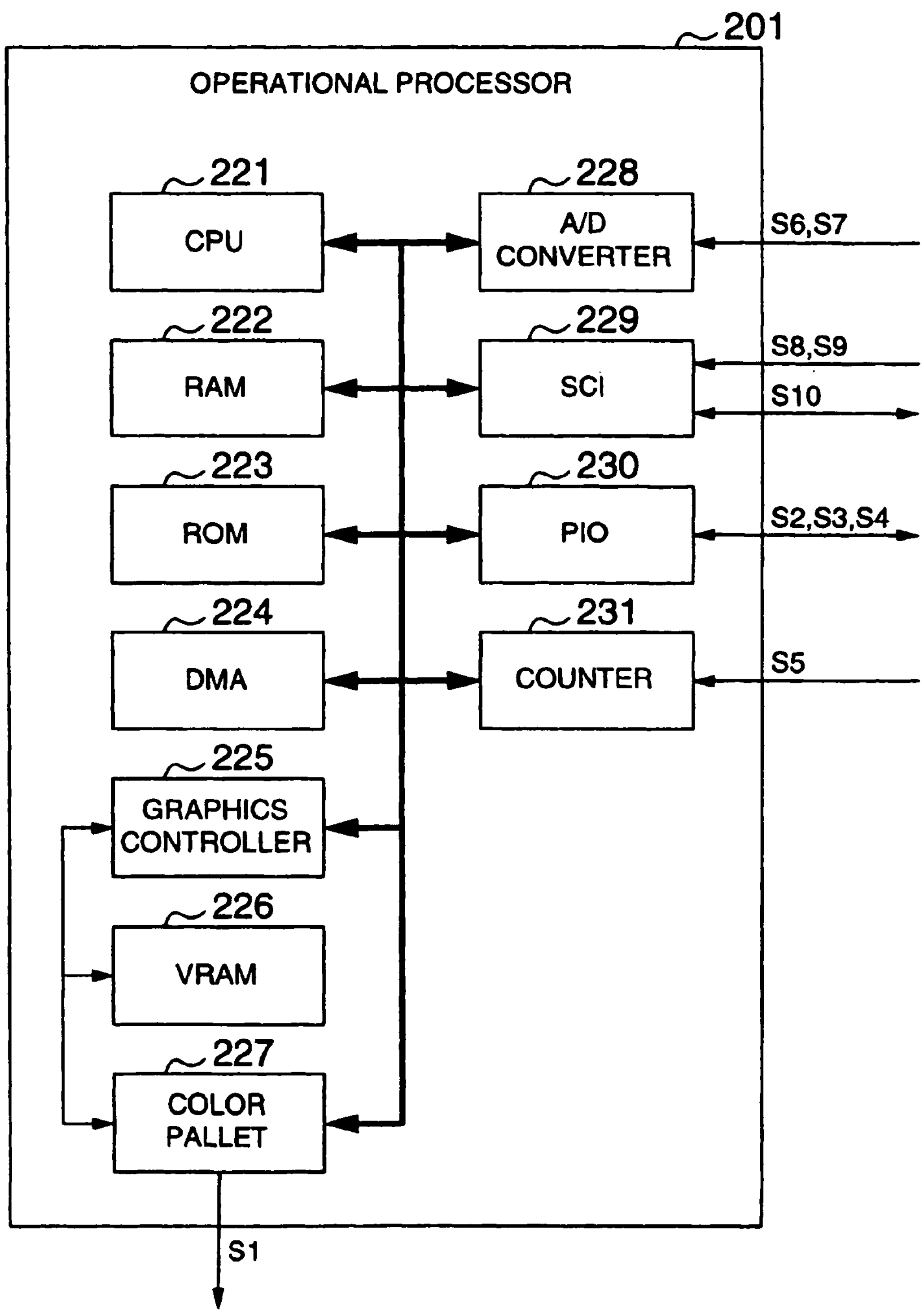

201
OPERATIONAL PROCESSOR
221
CPU
222
RAM
223
ROM
224
DMA
225
GRAPHICS CONTROLLER
226
VRAM
227
COLOR PALLET
228
A/D CONVERTER
229
SCI
230
PIO
231
COUNTER
S6,S7
S8,S9
S10
S2,S3,S4
S5
S1

FIG. 10

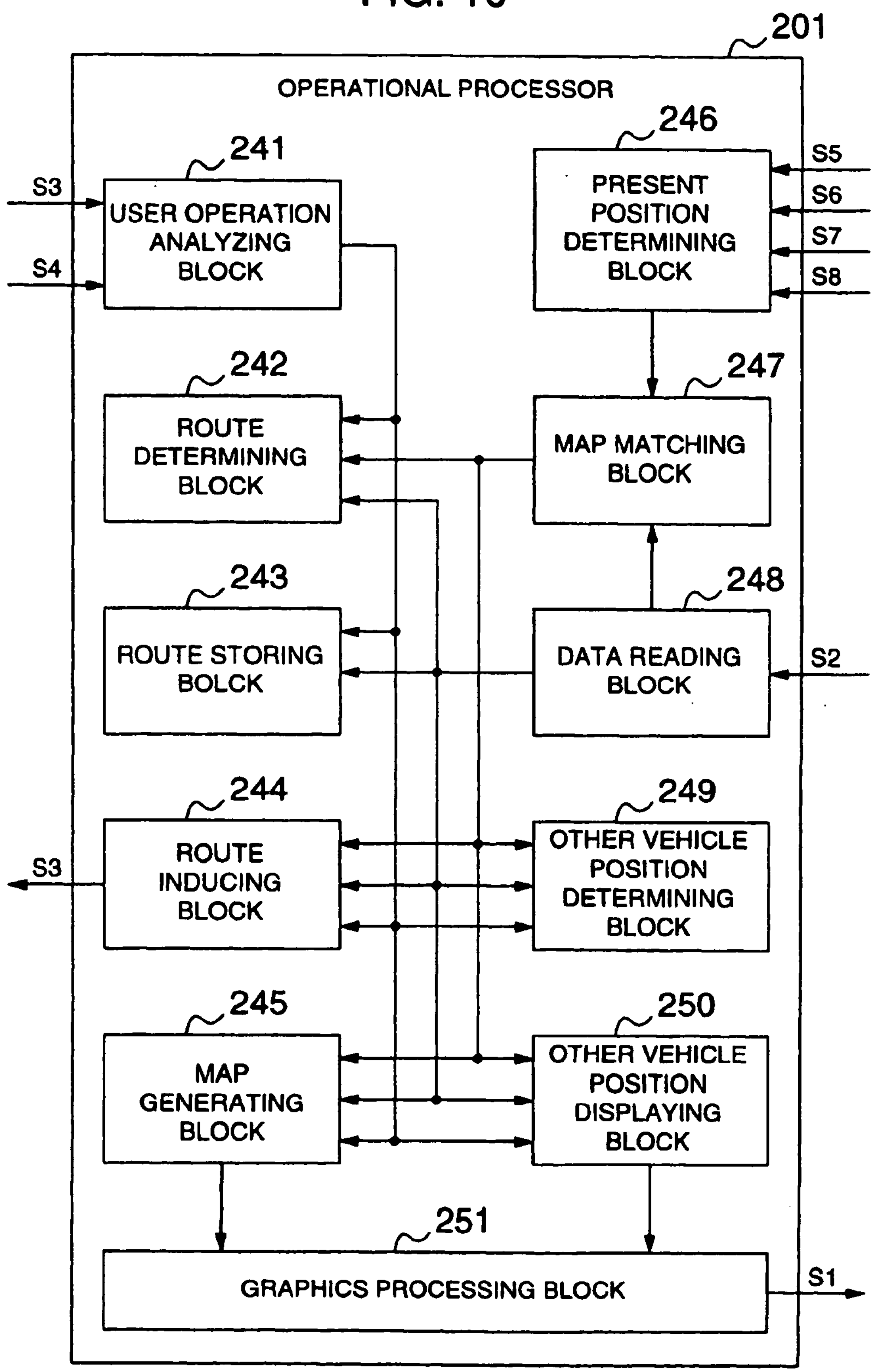

201
OPERATIONAL PROCESSOR
241
USER OPERATION ANALYZING BLOCK
S3
S4
246
PRESENT POSITION DETERMINING BLOCK
S5
S6
S7
S8
242
ROUTE DETERMINING BLOCK
247
MAP MATCHING BLOCK
243
ROUTE STORING BOLCK
248
DATA READING BLOCK
S2
244
ROUTE INDUCING BLOCK
S3
249
OTHER VEHICLE POSITION DETERMINING BLOCK
245
MAP GENERATING BLOCK
250
OTHER VEHICLE POSITION DISPLAYING BLOCK
251
GRAPHICS PROCESSING BLOCK
S1

FIG. 11

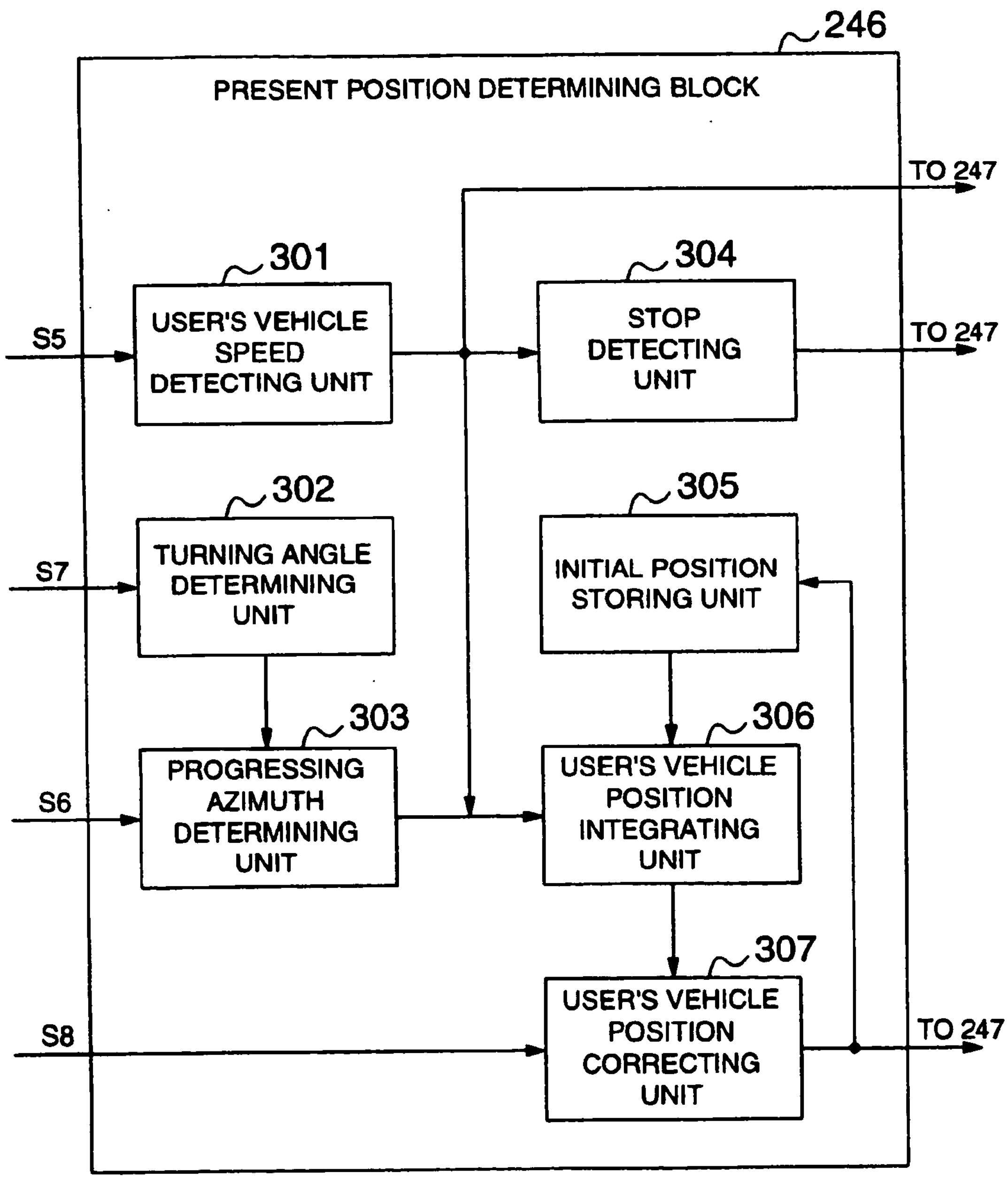

246
PRESENT POSITION DETERMINING BLOCK
TO 247
301
USER'S VEHICLE SPEED DETECTING UNIT
304
STOP DETECTING UNIT
TO 247
S5
302
TURNING ANGLE DETERMINING UNIT
305
INITIAL POSITION STORING UNIT
S7
303
PROGRESSING AZIMUTH DETERMINING UNIT
306
USER'S VEHICLE POSITION INTEGRATING UNIT
S6
307
USER'S VEHICLE POSITION CORRECTING UNIT
S8
TO 247

FIG. 12

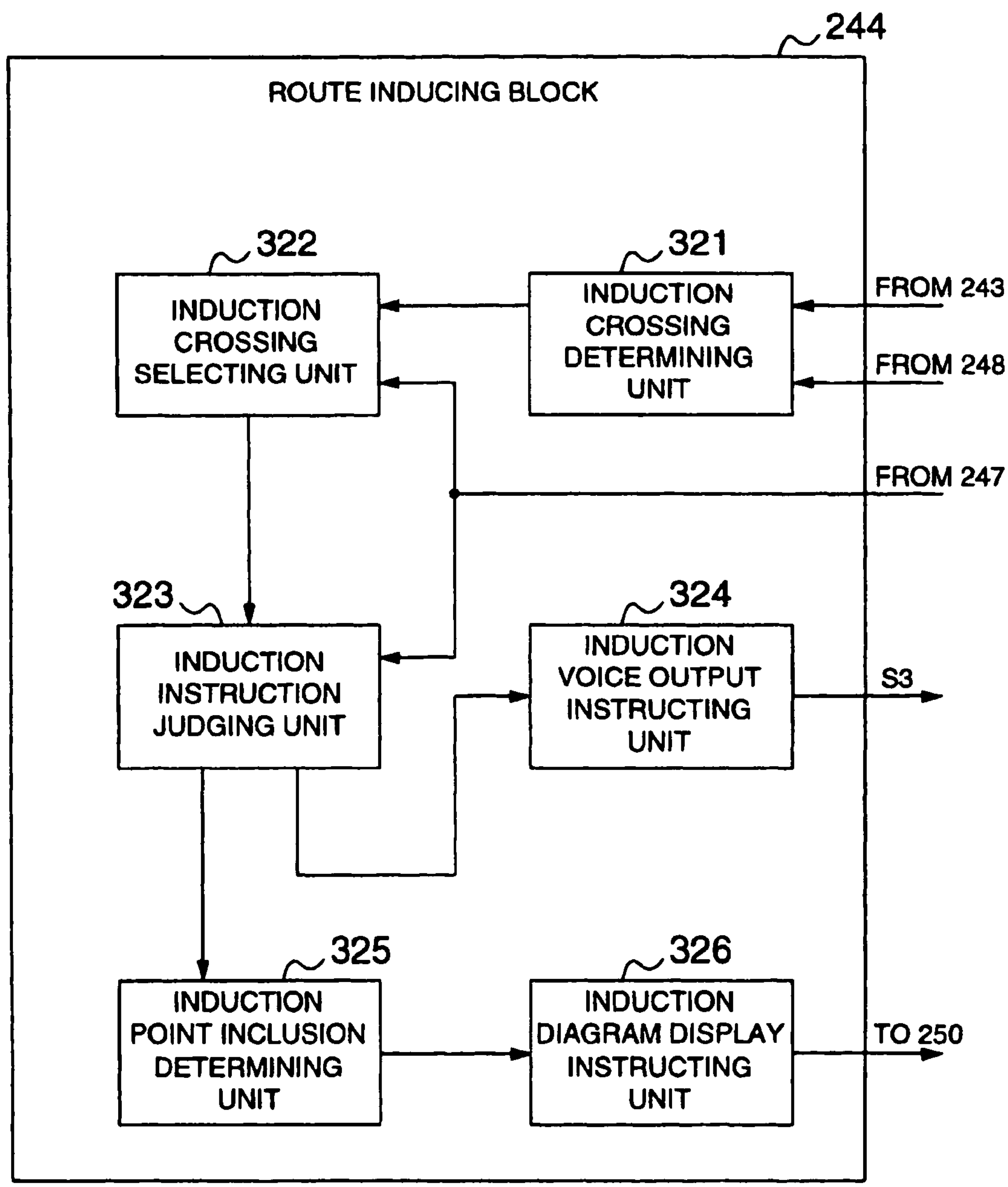

244
ROUTE INDUCING BLOCK
322
INDUCTION CROSSING SELECTING UNIT
321
INDUCTION CROSSING DETERMINING UNIT
FROM 243
FROM 248
FROM 247
323
INDUCTION INSTRUCTION JUDGING UNIT
324
INDUCTION VOICE OUTPUT INSTRUCTING UNIT
S3
325
INDUCTION POINT INCLUSION DETERMINING UNIT
326
INDUCTION DIAGRAM DISPLAY INSTRUCTING UNIT
TO 250

FIG. 13

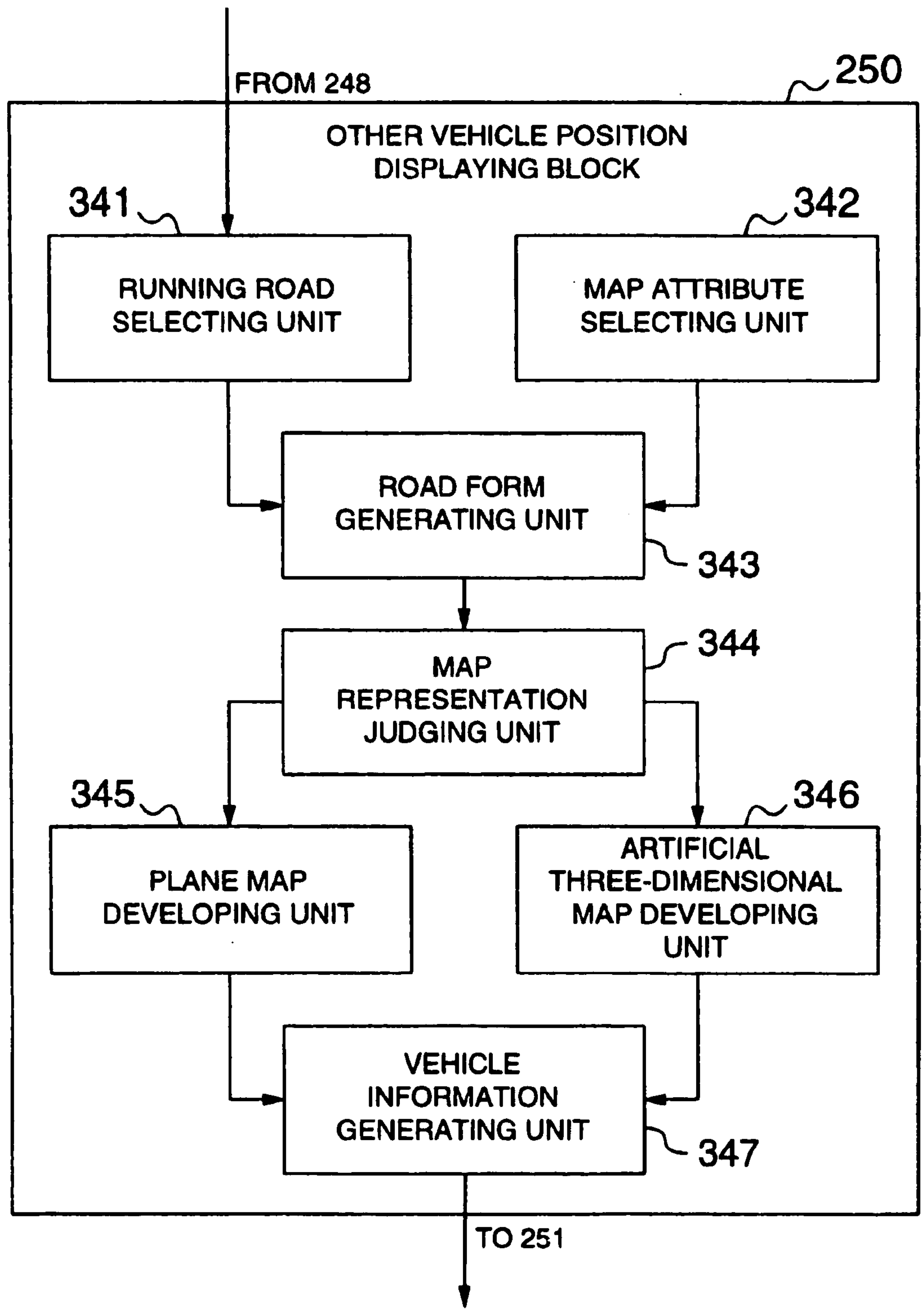

FROM 248
250
OTHER VEHICLE POSITION DISPLAYING BLOCK
341
RUNNING ROAD SELECTING UNIT
342
MAP ATTRIBUTE SELECTING UNIT
ROAD FORM GENERATING UNIT
343
MAP REPRESENTATION JUDGING UNIT
344
345
PLANE MAP DEVELOPING UNIT
346
ARTIFICIAL THREE-DIMENSIONAL MAP DEVELOPING UNIT
VEHICLE INFORMATION GENERATING UNIT
347
TO 251

FIG. 14

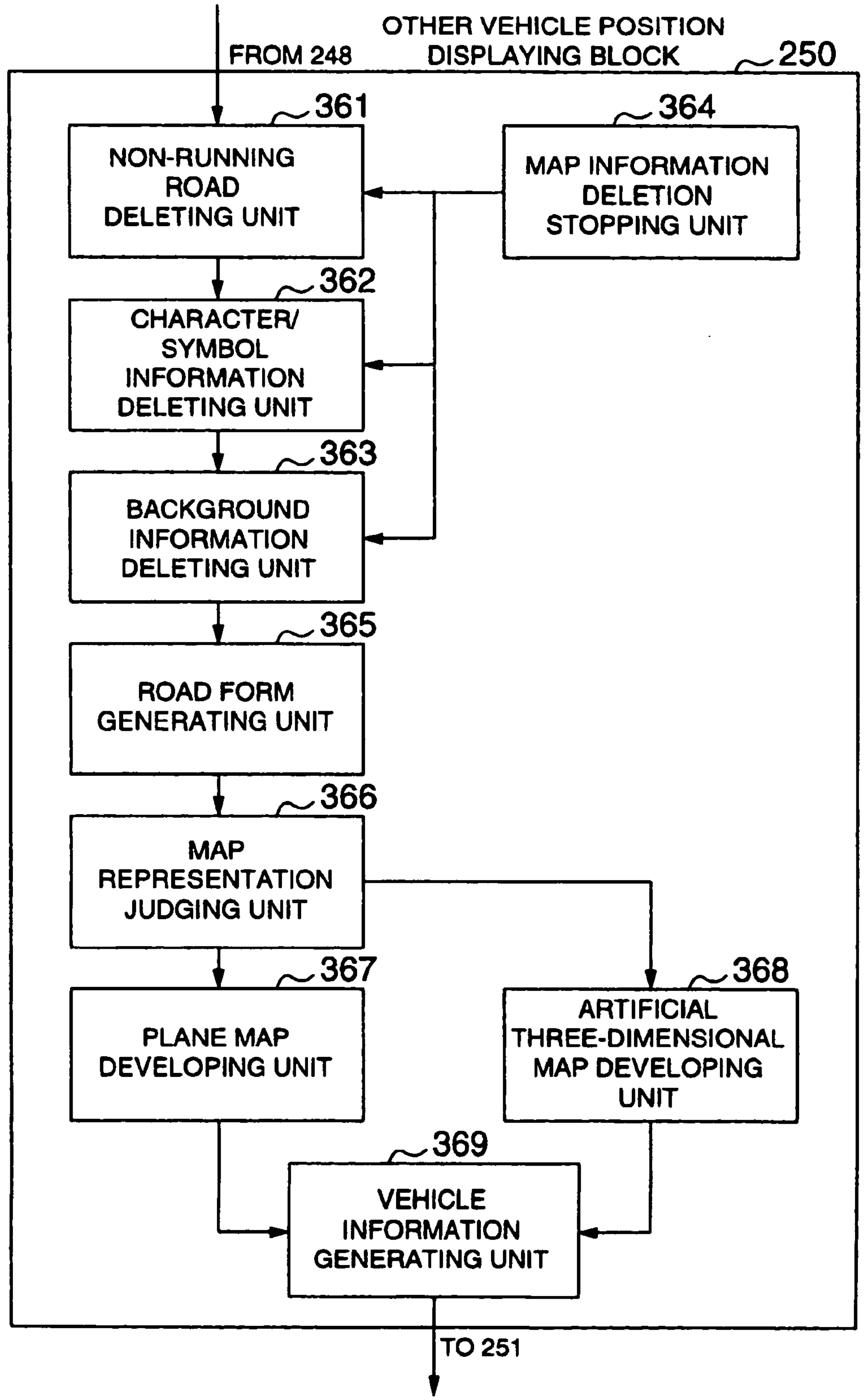

FROM 248
OTHER VEHICLE POSITION DISPLAYING BLOCK
250
361
NON-RUNNING ROAD DELETING UNIT
364
MAP INFORMATION DELETION STOPPING UNIT
362
CHARACTER/ SYMBOL INFORMATION DELETING UNIT
363
BACKGROUND INFORMATION DELETING UNIT
365
ROAD FORM GENERATING UNIT
366
MAP REPRESENTATION JUDGING UNIT
367
PLANE MAP DEVELOPING UNIT
368
ARTIFICIAL THREE-DIMENSIONAL MAP DEVELOPING UNIT
369
VEHICLE INFORMATION GENERATING UNIT
TO 251

FIG. 15

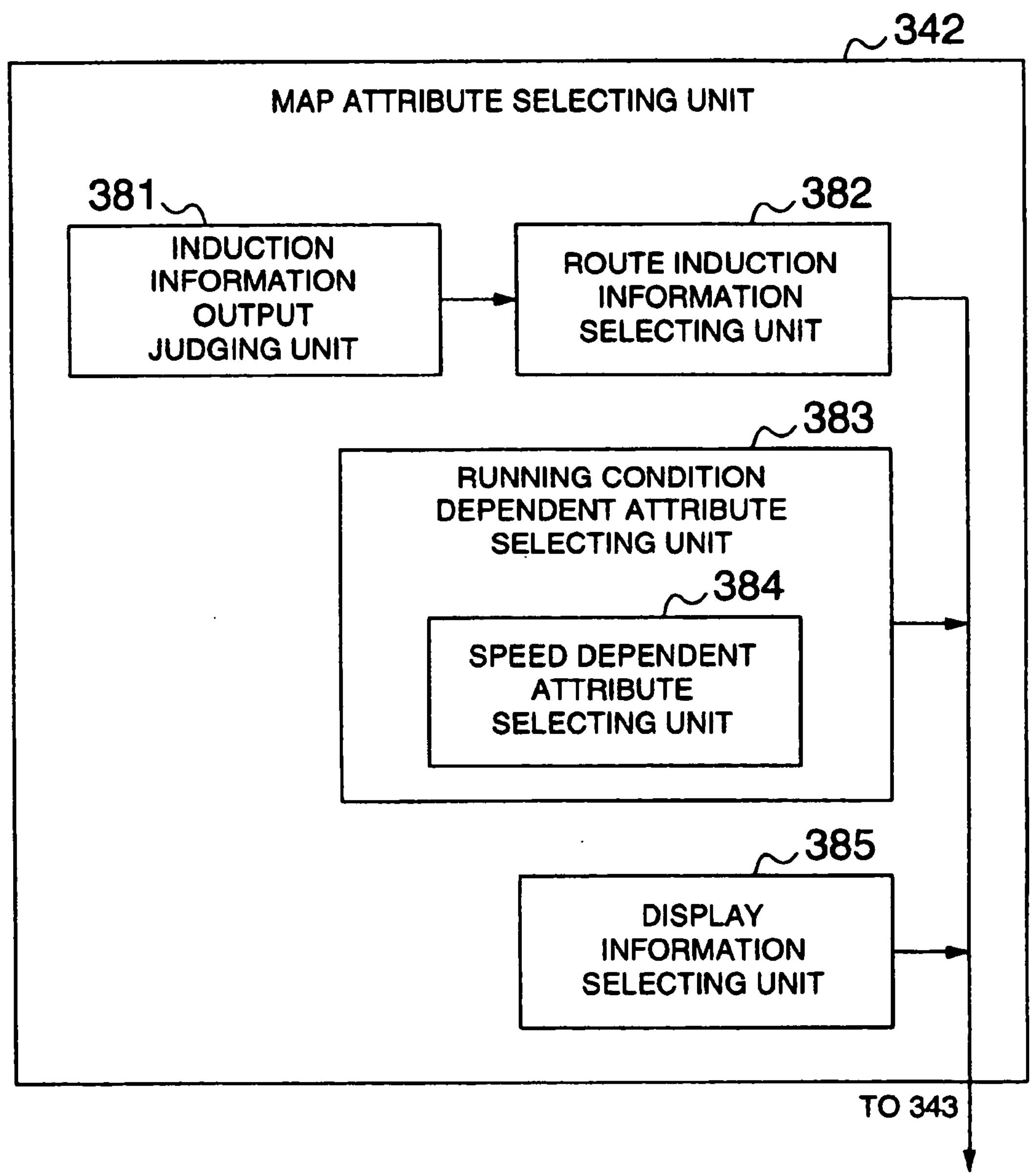

342
MAP ATTRIBUTE SELECTING UNIT
381
INDUCTION INFORMATION OUTPUT JUDGING UNIT
382
ROUTE INDUCTION INFORMATION SELECTING UNIT
383
RUNNING CONDITION DEPENDENT ATTRIBUTE SELECTING UNIT
384
SPEED DEPENDENT ATTRIBUTE SELECTING UNIT
385
DISPLAY INFORMATION SELECTING UNIT
TO 343

FIG. 16

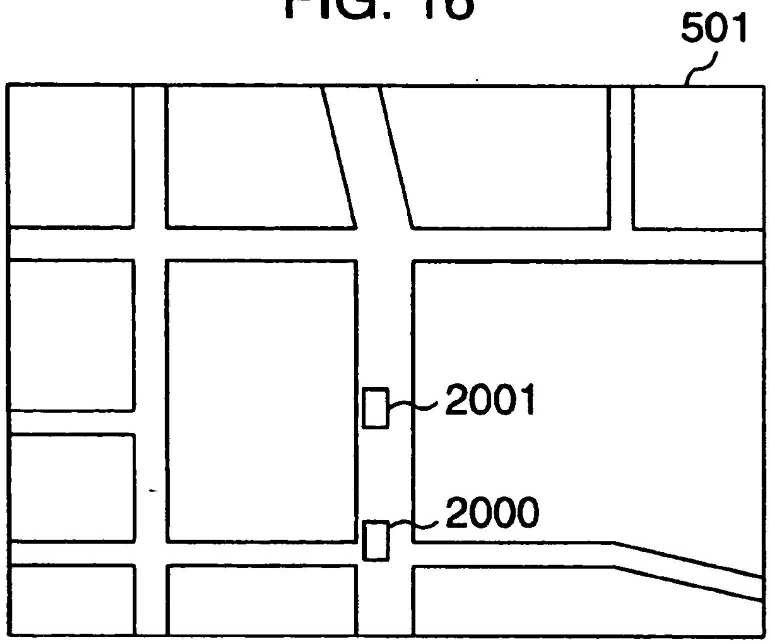


FIG. 17

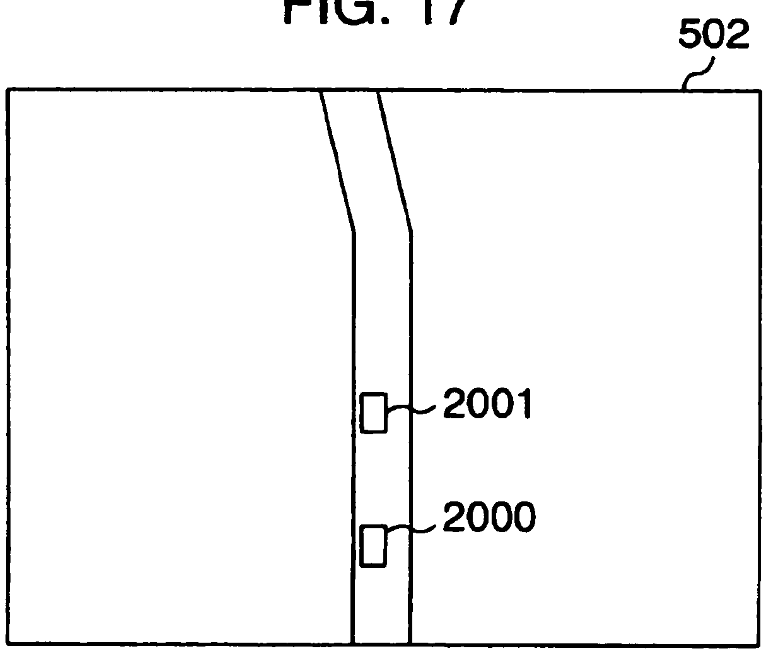


FIG. 18

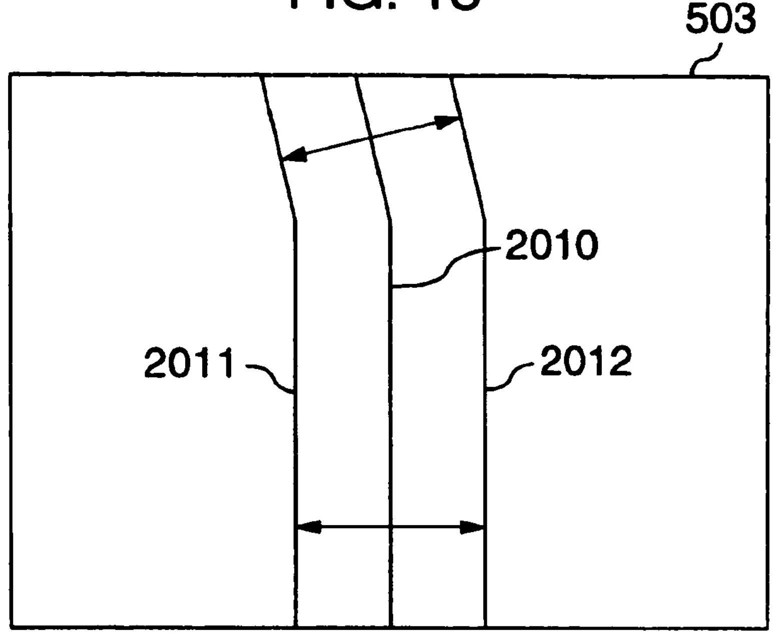


FIG. 19

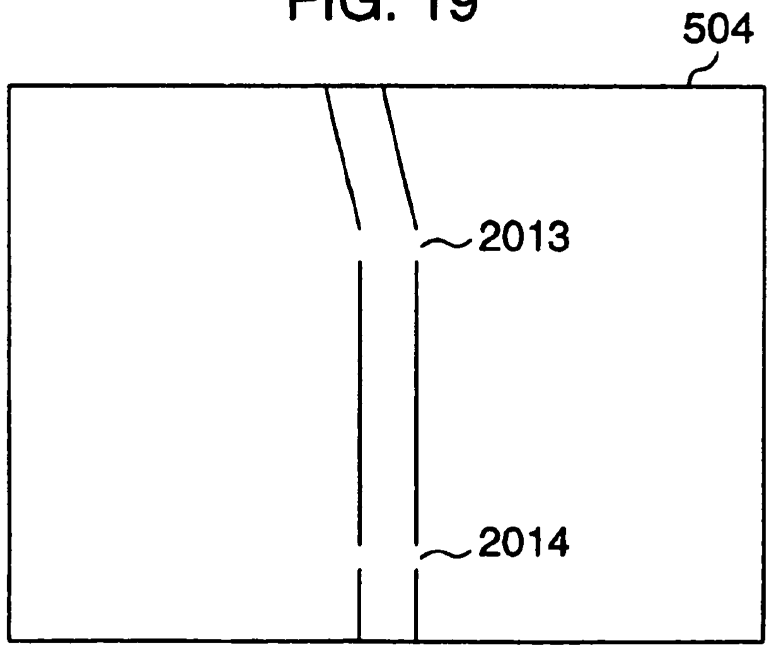


FIG. 20

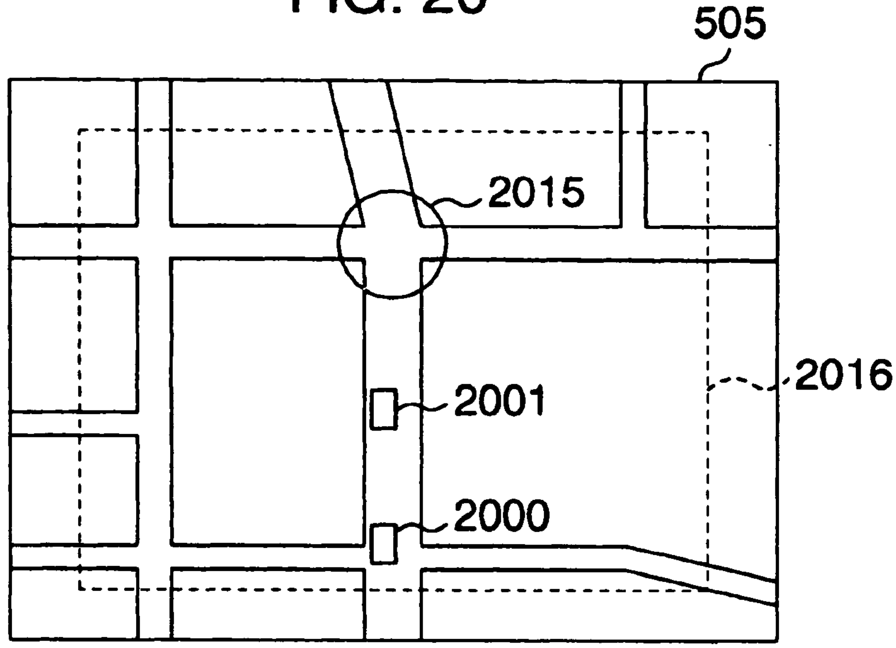


FIG. 21

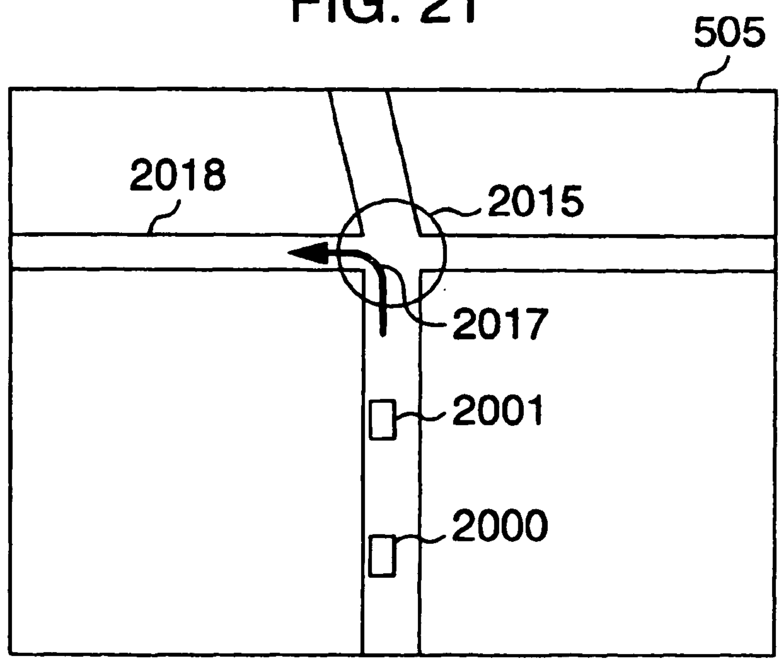
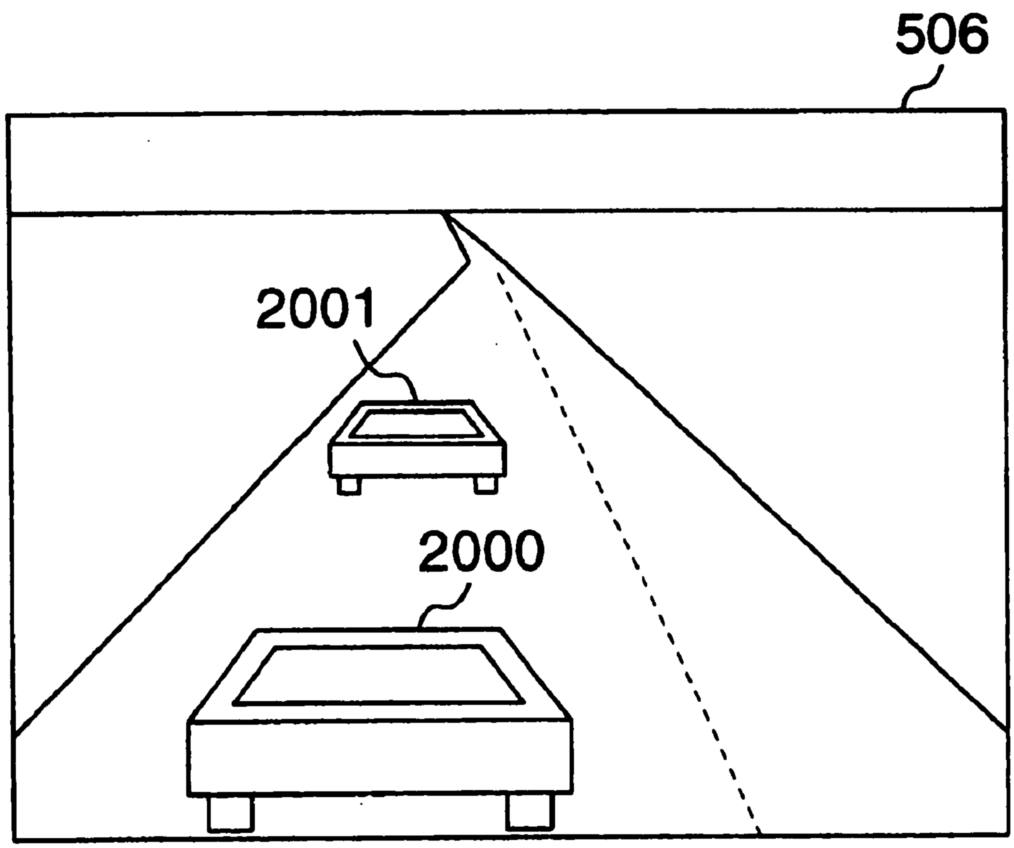


FIG. 22



VEHICLE POSITION INFORMATION DISPLAYING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a cruise control apparatus for motor vehicle, and more particularly to an apparatus and method in which position information of a peripheral vehicle around a user's vehicle or a preceding vehicle as the object of follow-up is displayed in a manner superimposed on a road form generated from map information.

In a cruise control apparatus for motor vehicle, it is general that in order to give information of the position and azimuth of a motor vehicle existing in the front, a method using peculiar hardware is employed or the display is provided on a graphics display unit possessed by a navigation device. In the method using the peculiar hardware, the fabrication cost is lowered by employing a system in which lumps such as LED's are continuously arranged so that an interval between a user's vehicle and a front vehicle is printed in accordance with the arranging positions of LED's and corresponding LED's are excited into illumination on the basis of measured relative distance information to inform the user of the relative distance.

On the other hand, in the system in which the display is provided on a graphics display unit such as LCD or CRT possessed by a navigation device or the like, it is general to employ a method in which a virtual straight road is generated and marks indicative of a user's vehicle and a front vehicle and a scale for grasping a relative distance are displayed on the generated virtual straight road. As a further high technique, there is a method in which an image of a running road is produced by an image pickup device such as CCD to extract the outlines of the road therefrom and marks indicative of a user's vehicle and a front vehicle and a scale for grasping a relative distance are displayed on the obtained road form. Also, there is a method which uses a distance measuring device or equipment (DME) using millimeter waves or a laser, that is, a method in which the form of a road is determined from information of a reflected version of a transmitted signal from a guard rail or the like existing in the side of the road and marks indicative of a user's vehicle and a front vehicle and a scale for grasping a relative distance are displayed on the obtained road form.

In a cruise control apparatus for motor vehicle, it is desired that the position of a motor vehicle existing in the front is displayed in a manner superimposed on an actual road form. This is because it is desirable to provide a clarified display as to whether the front vehicle is running on a lane under running of a user's vehicle or on a lane adjacent to the running lane. Such display is desired in the case of a curved road or the like. Further, it is desirable to display such information at a low cost and in a form capable of being easily understood by the user. In order to provide the easily understandable display, it is desirable that information on a display screen is made as simple as possible.

On the other hand, the conventional method using the peculiar hardware has neither means for recognizing the form of a road nor means for displaying it. In the method in which a virtual straight road is generated, an image different from the actual road form is generated so that it is not possible to provide the above-mentioned desirable display in a manner superimposed on the actual road form. The method using the image pickup device has a problem that the outlines of a road are undeterminable under a meteorological condition such as snow or mist as well as a problem that the system becomes high in cost. The method using the distance measuring device for determination of the form of a guard rail or the like to extract the outlines of a road has a problem that the determination of road outlines is difficult for a road which has not a guard rail or the like.

SUMMARY OF THE INVENTION

An object of the present invention made for solving the above-mentioned problems is to provide a low-cost and high-accuracy vehicle position information displaying apparatus and method in which position information of a user's vehicle and position information of a front vehicle are displayed in a manner superimposed on an actual road form. Another object of the present invention is to provide such apparatus and method in which a road subjected to the display of the road form can be limited to a running road, thereby simplifying or reducing the amount of displayed information.

According to a construction in the present invention for displaying the position of another (or peripheral) vehicle around a user's vehicle in a manner superimposed on an actual road form, a road under running of the user's vehicle is identified by use of position measuring means possessed by a navigation device and a map database to generate road outline information from information of the identified road, and the positions of the user's vehicle and a preceding vehicle existing in the front of the user's vehicle (and a peripheral vehicle other than the preceding vehicle existing around the user's vehicle) are displayed in a manner superimposed on the generated road form. The road under running of the user's vehicle is selected from map data stored in the map data-base, thereby simplifying or reducing the amount of displayed information.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a systematic diagram showing the construction of a vehicle position information displaying apparatus according to an embodiment of the present invention;

FIG. **2** is a diagram for explaining a state transition under the control of a cruise controller shown in FIG. **1**;

FIG. **3** is a flow chart for explaining a state change processing performed by the cruise controller;

FIG. **4** is a diagram for explaining the concept of a predicted inter-vehicle distance control system;

FIG. **5** is a flow chart showing a throttle command signal generating routine;

FIG. **6** is a diagram showing a first example of the predict ed inter-vehicle distance control system;

FIG. **7** is a diagram showing a second example of the predicted inter-vehicle distance control system;

FIG. **8** is a diagram showing the construction of a navigation device shown in FIG. **1**;

FIG. **9** is a block diagram showing the hardware construction of a n operational processor shown in FIG. **8**;

FIG. **10** is a block diagram showing the functional construction of the operational processor;

FIG. **11** is a block diagram showing the functional construction of a present position determining block shown in FIG. **10**;

FIG. **12** is a block diagram showing the functional construction of a route inducing block shown in FIG. **10**;

FIG. **13** is a block diagram showing a first example of the functional construction of an other vehicle position displaying block shown in FIG. **10**;

FIG. **14** is a block diagram showing a second example of the functional construction of the other vehicle position displaying block;

FIG. 15 is a block diagram showing the functional construction of a map attribute selecting unit shown in FIG. 13;

FIG. 16 is a diagram showing an embodiment in which roads around a user's vehicle are displayed;

FIG. 17 is a diagram showing an embodiment in which a road under running of a user's vehicle is displayed;

FIG. 18 is a diagram for explaining a method of generating a road form;

FIG. 19 is a diagram for explaining a method of generating a road form from residential area map data;

FIG. 20 is a diagram for explaining a judgement area for start of the display of an induction crossing;

FIG. 21 is a diagram for explaining a method of selecting a road connecting with the induction crossing; and

FIG. 22 is a diagram showing an embodiment in which a road under running of a user's vehicle is displayed in birds-eye view representation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of a vehicle position information displaying apparatus according to the present invention will be described in reference to the drawings.

FIG. 1 is a systematic diagram showing the construction of a vehicle position information displaying apparatus according to an embodiment of the present invention. The apparatus includes a distance measuring device or equipment (DME) **101** for measuring a distance between a user's vehicle and an object existing in the front, rear or lateral side of the user's vehicle and the azimuth of the user's vehicle, an image pickup device **102** for imaging the neighborhood of the user's vehicle, a cruise controller **103** provided with a function of controlling a driving mechanism of the user's vehicle (including an engine and a transmission) so that the user's vehicle runs while maintaining the speed of the user's vehicle or an inter-vehicle distance between the user's vehicle and a preceding vehicle at a target value, a navigation device **114** for displaying an image obtained by the image pickup device **102**, internal information of the cruise controller **103**, and control information including an output command value, a display unit **115** for displaying a graphics output of the navigation device **114**, an operation command input device **113** for inputting an operation command for the system by the user, a throttle valve controller **104** for controlling a throttle valve actuator **105** on the basis of each command value from the cruise controller **103** which actuator operates a throttle valve, a transmission controller **107** for controlling the speed changing operation of a transmission **106**, and a brake controller **108** for controlling a brake actuator **109** which operates a brake.

The distance measuring device **101** may be realized by, for example, a radio radar or a laser radar. The distance measuring device **101** is provided at the front, rear, lateral side or the like of the user's vehicle and outputs information including a distance between the user's vehicle and an object such as a motor vehicle existing around the user's vehicle, the azimuth of the user's vehicle, and so forth. Specific means for realizing such distance measurement includes a method as shown by JP-A-58-27678 or a measuring method using a radio radar by which radio waves are emitted in a running direction so that the speeds (or range rates), inter-vehicle distances (or ranges) and azimuths of a user's vehicle relative to a plurality of peripheral vehicles are measured from Doppler frequencies superimposed on reflected return waves, and a method as shown by JP-A-58-203524 or a measuring method using a pulsed laser radar by which a laser beam is outputted so that an inter-vehicle distance is measured from a time until a reflected beam returns.

The image pickup device **102** may be realized by, for example, a CCD camera. The image pickup device **102** outputs a video signal obtained through the imaging of the front, rear and side of the user's vehicle.

The operation command input device **113** may be realized by an ordinary hardware switch such as a push switch, or the combination of a microphone for receiving a voice or speech command and an analyzer for analyzing the voice command.

The cruise controller **103**, when the start of an operation thereof is instructed by the operation command input device **113**, controlling the driving mechanism so that the user's vehicle runs with the speed or inter-vehicle distance of the user's vehicle relative to a preceding vehicle being maintained at a set constant value even if the user's foot is released from an accelerator pedal.

A follow-up target vehicle determining device **110** determines a vehicle which is made a target for follow-up (hereinafter referred to as follow-up target vehicle) in the case where the cruise controller **103** operates a control function of performing the running with an inter-vehicle distance maintained at a set value (hereinafter referred to as follow-up running control function). The follow-up target vehicle determining device **110** is constructed by, for example, a vehicle selector **111** for selecting one of vehicles to be followed on the basis of information of front vehicles from the distance measuring device **101** and the image pickup device **102** and a controller **112** for controlling the cruise controller **103** to take the selected vehicle as a follow-up target vehicle. The selection of the vehicle to be followed is made in such a manner that each of objects subjected to the measurement of the distances and azimuths thereof by the distance measuring device **101** is judged as to whether or not that vehicle satisfies conditions which are previously set concerning an inter-vehicle distance, relative speed, relative angle and so forth thereof for the user's vehicle and should be satisfied by running vehicles to be followed.

The navigation device **114** operates to select a road under running of the user's vehicle on the basis of peripheral vehicle information obtained by the distance measuring device **101** and the image pickup device, present position measuring means possessed by the navigation device, and map information stored in the navigation device so that the form of the selected road is displayed on the display unit **115**. Such generation of the running road form using the map information stored in the navigation device enables more realistic display of the road. Further, the navigation device **114** operates to determine the displaying position of the user's vehicle so that it is fixed at one predetermined point on the display unit. Also, the navigation device **114** operates to display a mark **2000** (for example, see FIG. **16**) indicative of the position of the user's vehicle, a mark **2001** indicative of the position of a preceding vehicle and a mark indicative of a peripheral vehicle other than the preceding vehicle in a manner super-imposed on the road. Accordingly, the distances between the user's vehicle and the peripheral vehicles can easily be discriminated. It is preferable that the marks indicative of the positions of the user's vehicle, the preceding vehicle and the peripheral vehicle other than the preceding vehicle are provided with different displaying configurations, that is, changed colors or patterns. Thereby, the user can easily discriminate the type of information indicated by each mark.

Next, the outline of the follow-up running control of the operations of the vehicle position information displaying apparatus according to the present embodiment will be described in reference to a state transition diagram shown in FIG. 2 and a flow chart of a state change processing shown in FIG. 3.

In the follow-up running control in the present embodiment, the running condition of the vehicle is classified into three states including the state of normal running **131**, the state of fixed vehicle speed control **132** and the state of follow-up running control **133**. When a cruise control is instructed through the operation command input device **113** at the state of normal running **131**, a processing **1401** is performed so that a state transition is made from the state of normal running **131** to the state of fixed vehicle speed control **132** of causing the vehicle to run in a fixed speed condition.

In a processing **1402**, a front vehicle to be followed is selected on the basis of the inter-vehicle distances, speeds, angles and so forth of the user's vehicle relative to the other vehicles which are obtained by the distance measuring device **101** and the image pickup device **102**.

In a processing **1403**, the judgement is made of whether or not the inter-vehicle distance D(t) for the running vehicle to be followed selected in the processing **1402** is smaller than a target inter-vehicle distance $Dr(V_0)$ determined by the speed V_0 of the user's vehicle. In the case where the inter-vehicle distance D(t) is smaller than the target inter-vehicle distance $Dr(V_0)$, a follow-up running control processing **1405** for transition from the state of fixed vehicle speed control **132** to the state of follow-up running control **133** is performed. In the case where the inter-vehicle distance D(t) is larger than the target inter-vehicle distance $Dr(V_0)$ determined by the speed of the user's vehicle, a processing **1404** is performed with the state of fixed vehicle speed control **132** being maintained. In the fixed vehicle speed control processing **1404**, calculation is performed for controlling the opening angle of the throttle valve so that the speed of the user's vehicle takes a value determined by the user or driver.

The contents of the follow-up running control processing **1405** shown in FIG. **3** will be described using FIGS. **4** and **5**.

FIG. **4** shows a conceptual diagram of a control system using predicted inter-vehicle distances Da, Dn and Dd between the follow-up target vehicle and the user's vehicle. There is assumed the case where the inter-vehicle distance D oscillates around the target inter-vehicle distance Dr and the inter-vehicle distance D(T1) between the user's vehicle and the follow-up target vehicle at present time T1 has a deviation ΔD.

In the shown example, the inter-vehicle distance Da at time T2, in the case where the user's vehicle is accelerated at present time T1, is predicted by use of a vehicle model in a processing which will be mentioned later on. Similarly, there are predicted the inter-vehicle distance Dd at time T2 in the case where a deceleration control is performed and the inter-vehicle distance Dn at time T2 in the case where the user's vehicle runs as it is. The predicted values are shown in FIG. 4. In the shown example, the running control is made by performing a processing for selecting one of the three predicted values Da, Dn and Dd nearest to the target inter-vehicle distance Dr.

A routine for generating a throttle command signal to be outputted for vehicle speed control in the follow-up running control in the present example will be described referring to a flow chart shown in FIG. **5**.

In a processing **1501**, an inter-vehicle distance D between a preceding running vehicle and the user's vehicle is measured using the distance measuring device **101**.

In a processing **1510**, the judgement is made of whether or not the measurement of the inter-vehicle distance D results in success. If the inter-vehicle distance D is normally measured, the flow branches to a processing **1502**. In the case where the measurement results in failure, the flow branches to a processing **1511** in which the preceding predicted inter-vehicle distance is used as the value of the inter-vehicle distance D.

FIG. **6** shows an example in which the preceding predicted inter-vehicle distance is used as the value of the inter-vehicle distance D. At time T1, a deceleration signal was outputted as the result of operation at time T1. In the case where the measurement of the inter-vehicle distance D at time T2 results in failure, predicted inter-vehicle distances Da, Dn and Dd at time T2+Tc are thereinstead determined by use of a predicted inter-vehicle distance Dd' determined at time T1. And, an acceleration signal providing a predicted inter-vehicle distance Da nearest to the target inter-vehicle distance Dr is outputted. However, since the predicted inter-vehicle distance Dd' is determined by use of the vehicle model shown in FIG. **4**, there is an error De (see FIG. **4**) from an inter-vehicle distance D at time T2 in the case where the measurement results in success. Accordingly, the continuous use of this predicted inter-vehicle distance Dd' is not preferable since the error is accumulated. The maximum number of times of continuous use of the predicted inter-vehicle distance is limited to, for example, 3. In the case where the failure of the measurement of the inter-vehicle distance D continues beyond 3 times, the follow-up running control mode **133** is temporarily stopped and the running in the fixed vehicle speed control mode **132** is performed until the measurement of the inter-vehicle distance D results in success.

The processing **1502** is required only in the case where only the measurement of an inter-vehicle distance is possible, as in the case where a pulsed radar is used. If the measurement of a relative vehicle speed is possible, as in a CW system such as a radio radar, the processing **1502** may be omitted. In the processing **1502**, a relative speed Vr can approximately be determined, for example, in such a manner that a difference between an inter-vehicle distance D' preceding by one sampling period and the present inter-vehicle distance D is divided by one sampling period.

In a processing **1503**, there is determined a predicted inter-vehicle distance Da in the case where an acceleration signal is outputted. The inter-vehicle distance Da at time T2 is predicted by inputting+α (corresponding to acceleration) to the vehicle model prepared beforehand.

In a processing **1504**, there is predicted a future inter-vehicle distance Dd in the case where a deceleration signal is outputted. The predicted inter-vehicle distance Dd is determined by inputting−α (corresponding to deceleration) in a manner similar to that in the processing **1503**.

In a processing **1505**, there is predicted a future inter-vehicle distance Dn in the case where neither an acceleration nor deceleration signal is outputted.

A search for one of the thus predicted inter-vehicle distances Da, Dn and Dd nearest to the target inter-vehicle distance Dr is made in processings **1506** and **1507**. In the case where the predicted inter-vehicle distance nearest to the target inter-vehicle distance Dr is Da when the acceleration signal is outputted, the flow branches from the processing **1506** to a processing **1508**. In the other cases, the flow

branches to the processing 1507. In the processing 1508, a signal for increasing the throttle valve opening angle by $\Delta\theta$ is outputted to the throttle valve controller 104, thereby completing the flow.

In the case where it is determined in the processing 1507 that the predicted inter-vehicle distance nearest to the target inter-vehicle distance Dr is Dd when the deceleration signal is outputted, the flow branches to a processing 1512. In the case where neither acceleration nor deceleration is required or the present throttle valve opening angle is maintained, the flow is completed as it is. In the processing 1512, the predicted inter-vehicle distance Dd is compared with an inter-vehicle distance Dc with which the release from automatic cruise is made. If $Dc \leqq Dd$, the flow branches to a processing 1509. If $Dc > Dd$, the flow branches to a processing 1513. In the processing 1509, a signal for decreasing the throttle valve opening angle by $\Delta\theta$ is outputted to the throttle valve controller 104, thereby completing the flow.

In the processing 1513, a signal for setting the throttle valve opening angle to full close ($\Delta\theta$ min) is outputted to the throttle valve controller 104. FIG. 7 shows an example of the predicted inter-vehicle distance in the case where the branch to the processing 1513 is taken. Predicted inter-vehicle distances Da, Dn and Dd at time T10+Tc are determined from an inter-vehicle distance D at time T10. In the present example, it is shown that if an acceleration signal is outputted, the predicted inter-vehicle distance Dd takes zero so that the user's vehicle collides with the preceding vehicle. Even if a deceleration signal is outputted, the predicted inter-vehicle distance Dd is smaller than Dc so that it remains as a very dangerous inter-vehicle distance. By setting the throttle valve opening angle to full close to apply a strong engine brake so that the deceleration is made, the collision is prevented. The inter-vehicle distance Dc with which the throttle opening angle is set to full close is set for each vehicle.

FIG. 8 is a diagram for explaining an example of the construction of the navigation device 114. Each constituent unit of the navigation device will now be described.

An operational processor 201 is a central unit for performing various processings which include detecting a present position on the basis of sensor information outputted from various sensors 206 to 209, reading map mesh data necessary for display of a running road from a map memory 203 on the basis of the obtained present position information, graphically developing the map data so that a mark indicative of the position of a user's vehicle and a mark indicative of the position of a peripheral vehicle measured by the distance measuring device 101 are displayed on the display unit 115 in a manner superimposed on the developed map, and selecting an optimum route connecting the present place and a destination designated by the user so that the selected route is displayed in a manner superimposed on the running road on the display unit 115, thereby inducing the user to the destination.

The display unit 115 is a unit for displaying graphics information generated by the operational processor 201. The display unit 115 may be constructed by a CRT or a liquid crystal display. It is general that a signal S1 between the operational processor and the display unit is a GRB signal or an NTSC (National Television System Committee) signal.

The map memory 203 is constructed by a large-capacity storage medium such as CD-ROM, DVD-ROM or IC card. Map mesh data or the like necessary for display of a map is stored in the map memory 203.

A voice input/output unit 204 performs a processing for outputting a message for the user generated by the operational processor 201 in a form converted into an audio signal and a processing for recognizing a voice issued by the user and transferring the contents thereof to the operational processor 201.

An input unit 205 is a unit for receiving an instruction from the user. The input unit 205 is constructed by a hardware switch such as scroll key or scale change key, a joy stick, a touch panel applied on a display, or the like.

The sensors used for position detection in the moving body navigation device include a wheel speed sensor 206 for measuring a distance from the product of the circumference of a wheel and the measured rotating speed of the wheel and further measuring the curving angle of the moving body from a difference between the rotating speeds of paired wheels, a geomagnetic sensor 207 for detecting a magnetic field held by the earth to detect an azimuth to which the moving body points, a gyro 208 such as optical fiber gyro or vibrating gyro for detecting an angle by which the moving body turns, and a GPS receiver 209 for measuring the present position, progressing speed and progressing azimuth of the moving body by receiving a signal from a GPS satellite to measure a distance between the moving body and the GPS satellite and the rate of change in distance in connection with three or more satellites. The GPS receiver 209 can obtain time information and date information by analyzing signals sent from the GPS satellites.

Further, there is provided a traffic information receiver 210 for receiving a signal from a beacon transmitter or FM multiplex broadcasting which issues traffic information including traffic jam information of roads, regulation information such as construction and no-thoroughfare, and parking place information.

Various information in the vehicle, for example, information of peripheral vehicles sent from the follow-up target vehicle determining device 110, door open/close information, the kinds and conditions of lighted lumps, the conditions of the engine, failure diagnosis results, and so forth are transmitted to the navigation device through an in-vehicle LAN unit 211.

FIG. 9 is a diagram for explaining the hardware construction of the operational processor 201. Each constituent element will now be described.

The operational processor 201 is constructed by devices 221 to 231 which are connected by a bus. The constituent elements include a CPU 221 for performing various processings such as numerical operation and the control of each device, a RAM 222 for storing maps, search data and operation data, a ROM 223 for storing processing programs and data, a DMA (Direct Memory Access) 224 for performing the transfer of data between the memories and between the memory and each device at a high speed, a graphics controller 225 for performing a high-speed graphics drawing for development of vector data to pixel data and a display control, a VRAM 226 for storing graphics image data, a color pallet 227 for converting image data formed by an ID code of each color into a luminance information signal of RGB, an A/D converter 228 for converting an analog signal into a digital signal, an SCI 229 for converting a serial signal into a parallel signal synchronous with the bus, a PIO 230 for carrying the parallel signal onto the bus in a synchronized manner, and a counter 231 for integrating a pulse signal.

FIG. 10 is a block diagram for explaining the functional construction of the operational processor 201. Each constituent element will now be described.

A present position determining block 246 performs a processing for determining the position (X', Y') of the

moving body after running from an initial position (X, Y) in such a manner that using angle data obtained as the result of integration of each of distance pulse data S5 measured by the wheel speed sensor **206** and angular acceleration data S7 measured by the gyro **208**, the obtained data is integrated with respect to a time axis. In order to provide a matched relationship between the turning angle of the moving body and the progressing azimuth thereof, azimuth data S6 obtained from the geomagnetic sensor **207** and angle data obtained by integrating the angular acceleration data S7 obtained from the gyro **208** are mapped in a one-to-one correspondence relationship to correct the absolute azimuth of the moving body in a progressing direction thereof. Also, the integration of data obtained from the sensor yields the accumulation of an error of the sensor. Therefore, information of the present position is outputted through a processing for cancelling the accumulated error on the basis of position data S8 obtained from the GPS receiver **209** at a certain period.

Since sensor error is included in the present position information obtained by the present position determining block **246**, a map matching block **247** performs a map match processing for the purpose of improving the precision of position information, that is, a processing in which road data included in a map around the present place read by a data reading block **248** is collated with a running locus obtained from the present position determining block **246** so that the present place is matched with a road having the highest correlation in form. With the map match processing, the present place coincides with the running road in many cases, thereby making it possible to output the present position information at a high precision. The map matching block **247** transfers the correlated road information to an other vehicle position displaying block **250**.

A user operation analyzing block **241** receives a request from the user by the voice input/output device **204** or the input unit **205**, analyzes the contents of the user's request (S3 or S4) and controls each block so that a corresponding processing is performed. For example, when the user makes a request for the induction from the present place to a destination via a plurality of predetermined passing-through places, the user operation analyzing block **241** requests a map generating block **245** to perform a processing for displaying a map in order to display the destination and the passing-through places. Also, the user operation analyzing block **241** requests a route determining block **242** to perform a processing for determining a route from the present place to the destination through the passing-through places. Further, the user operation analyzing block **241** provides a selecting screen to the user for selecting map attributes to be displayed in a manner superimposed on the running road, and transfers the result of selection to the other vehicle position displaying block **250**.

The route determining block **242** searches map data for links/nodes from the present place toward the destination via the passing-through places by use of a Dykistra method or the like, and stores a route obtained as the result of search into a route storing block **243**. By changing the weighting of the node, it is possible to determine a route with which a distance between two points becomes the shortest, a route with which the arrival is possible in the shortest time, a route with which the cost becomes the lowest, or the like.

A route inducing block **244** compares node information of an inducing route stored in the route storing block **243** with present position information determined by the present position determining block **246** and the map matching block **247** to inform the user, by use of a voice through the voice input/output unit **204** before the passing through a crossing, of whether the vehicle should go straight ahead or should make right/left turn or the like or to inform the user of a route by instructing the map generating block **245** and the other vehicle position displaying block **250** to display an inducing arrow in a manner superimposed on road form information including a crossing to which the user's vehicle should be induced.

An other vehicle position determining block **249** determines the absolute position of the peripheral vehicle from that information of a relative distance between the peripheral vehicle and the user's vehicle and the direction to the peripheral vehicle which are transferred through the in-vehicle LAN unit **211** from the distance measuring device **101** and the image pickup device **102** and that information of the absolute position of the user's vehicle which is outputted by the map matching block **247**. The absolute position of the peripheral vehicle can easily be determined from the absolute position of the present place and information of a vector to the peripheral vehicle.

The map generating block **245** performs its operation in which map data of the vicinity of a point requested for the display thereof is read from the data reading block **248** and a command for drawing a designated object at a designated scale and in accordance with a designated drawing system is transferred to a graphics processing block **251**.

The other vehicle position displaying block **250** operates so that it selects information of roads connecting to the running road from data of roads around the present place read by the data reading block **248** by use of running road information outputted by the map matching block **247** and develops the selected road information to a drawing command. Further, the other vehicle position displaying block **250** operates so that it develops a command for drawing marks indicative of the absolute position of the user's vehicle, the absolute position of a preceding vehicle as the object of follow-up running and the absolute position of a peripheral vehicle existing around the user's vehicle in a manner superimposed on the running road. The command is transferred to the graphics processing block **251**. In the case where the vehicle selector **111** of the follow-up target vehicle determining device **110** determines the preceding vehicle so that a cruise control is started, the navigation device receives the start signal and operates to change the display screen to a mode in which the absolute position of the user's vehicle and the absolute position of the preceding vehicle as the object of follow-up running are displayed in a manner superimposed on the running road form outputted by the other vehicle position displaying block **250**. Thereby, the position information of the preceding vehicle as the object of follow-up running is displayed while the cruise control is being made. Therefore, it is possible for the user to know that the follow-up control is effected.

When the drawing commands generated by the map generating block **245** and the other vehicle position displaying block **250** are received, the graphics processing block **251** develops image data to the VRAM **226**.

FIG. **11** is a diagram for explaining the functional construction of the present position determining block **246**. Each constituent element will now be described.

A user's vehicle speed detecting unit **301** receives a wheel rotation pulse signal S5 from the wheel speed sensor **206** to determine the running speed of the user's vehicle from the number of pulses received within one unit time and to determine the running distance of the user's vehicle by multiplying the number of rotation pulses received within one unit time by a running distance corresponding to one pulse.

A stop detecting unit **304** monitors the running speed outputted from the user's vehicle speed detecting unit **301** to judge whether or not the running speed is 0 km/h or lower than a predetermined speed. The stop detecting unit **304** informs the map generating block **245** and the other vehicle position displaying block **250** through the map matching block **247** of a stop signal in the case where the running speed is 0 km/h and a low-speed running signal in the case where the running speed is lower than the predetermined speed. The stop detecting unit **304** may inform the map generating block **245** and the other vehicle position displaying block **250** through the map matching block **247** of the running speed of the user's vehicle.

A turning angle determining unit **302** receives a signal S7 from the gyro **208** such as an optical fiber gyro or a vibrating gyro for detection of a turning angle to determine an angle by which the user's vehicle turns per one unit time.

A progressing azimuth determining unit **303** determines the progressing azimuth of the user's vehicle by adding the turning angle determined by the turning angle determining unit **302** to azimuth information obtained in the preceding operation. An,initial value of the azimuth information herein used may be azimuth information stored in a non-volatile memory before the cut-off of a power supply. Further, the obtained azimuth information is corrected through comparison with azimuth information S6 obtained from the geomagnetic sensor **207**. The azimuth information thus corrected or azimuth information corrected by the map matching block **247** is used to make the correction of internally used azimuth information at any time, thereby maintaining the precision.

A user's vehicle position integrating unit **306** determines the present position through an operation in which a progressing azimuth vector given by a progressing distance of the user's vehicle per one unit time and azimuth information is added to position information obtained from an initial position storing unit **305** and the value of addition is integrated.

A user's vehicle position correcting unit **307** compares absolute position information S8 obtained from the GPS receiver **209** and position information obtained by the user's vehicle position integrating unit **306**. In the case where a difference between both the position information is within a predetermined distance, the position information from the user's vehicle position integrating unit **306** is outputted from the user's vehicle position correcting unit **307** to the map matching block **247**. In the case where the difference is larger than the predetermined distance beyond a predetermined time, the absolute position information from the GPS receiver **209** is outputted to the map matching block **247**. At the same time, the position information is stored into the initial position storing unit **305** and is in turn used for operation in the user's vehicle position integrating unit **306**.

FIG. **12** is a diagram for explaining the functional construction of the route inducing block **244**. Each constituent element will now be described.

An induction crossing determining unit **321** reads node/link data of an inducting route from the present place to a destination via passing-through places from the route storing block **243** and reads map data from the data reading block **248**. Further, the induction crossing determining unit **321** refers to the map data to search for whether or not each node forming the inducting route forms a crossing. When two links intersect at a certain node, the node is judged as being a bend of a road. When three or more links intersect at a node, the node is judged as being a crossing. In the case where the judgement as being a crossing is made, an angle formed between links connecting with a node forming the crossing in the inducting route is checked in order to judge whether or not a right/left turn should be made at that node. For a side having an angle smaller than 180 degrees, the judgement is made as to whether or not the angle is smaller than a predetermined value. The predetermined value for judgement may be about 120 degrees. In the case where it is determined that the angle is smaller than the predetermined value, the corresponding crossing is an induction crossing at which a right/left turn should be made. Therefore, the corresponding node is registered as an induction crossing.

An induction crossing selecting unit **322** searches for induction crossings which exist within a predetermined distance from the present position. Accordingly, one or plural induction crossings existing within the predetermined distance from the present position are selected.

An induction instruction judging unit **323** gives an instruction for operation to an induction voice output instructing unit **324** or an induction point inclusion judging unit **325** and an induction diagram display instructing unit **326** in accordance with an inducing method set by the user and analyzed by the user operation analyzing block **241**. For example, in the case where induction by voice is turned on, the instruction for operation is given to the induction voice output instructing unit **324**. In the case where the display of an induction diagram is turned on, the instruction for operation is given to the induction diagram display instructing unit **326**.

The induction voice output instructing unit **324** instructs the voice input/output unit **204** to output an inducing voice at a point of time when a distance between an induction crossing and the user's vehicle becomes a preset distance. For example, in the case where the preset distance is 100 m, the voice input/output unit **204** is instructed, at the point of time corresponding to that distance, to output an inducing voice of, for example, "please left-turn 100 m ahead".

The induction point inclusion judging unit **325** judges whether or not a distance between an induction crossing and the position of the user's vehicle comes to a preset distance, and informs the induction diagram display instructing unit **326** of the arrival at the induction crossing at a point of time when the preset distance is reached. Also, the induction point inclusion judging unit **325** detects the running of the user's vehicle away from the induction crossing beyond a predetermined distance and informs the induction diagram display instructing unit **326** of that effect. When informed of the arrival at the induction crossing, the induction diagram display instructing unit **326** instructs the other vehicle position displaying block **250** to display an induction diagram. On the other hand, when informed of the effect that the user's vehicle gets away from the induction crossing, the induction diagram display instructing unit **326** instructs the other vehicle position displaying block **250** to stop the display of the induction diagram. Thereby, it is possible to display induction information when the user's vehicle reaches a position on the inducting route which is before the induction crossing by the preset distance.

FIG. **13** is a diagram for explaining a first example of the functional construction of the other vehicle position displaying block **250**. Each constituent element will now be described.

The map matching block **247** selects a road matching with the running locus and gives notice of information of the selected road in a format including a mesh number of a map

in which the selected road is included, and a road link number or a node number. With this information used, a running road link connecting with a road link under running of the user's vehicle is selected by a running road selecting unit **341** from the road information outputted by the map matching **247** and map information read by the data reading block **248** in order to select a road on which the user's vehicle has run and a road having a high possibility that the user's vehicle will run on that road. In selecting the road link connecting with the road link under running, the running road selecting unit **341** operates to select data of the same type of road in substance. In the case where the same type of road forks into three or more branches at the same node, road data matching in road name (such as 1st national road, 25th prefectural road or Miura highway) with the road under running may be selected. Further, a road near to straight advance may be selected from among similar branches. Also, the running road selecting unit **341** may operate to select a road link corresponding to a road included in map data in which data of the road under running is included and which has a large map scale and a coarse data density. Thereby, it becomes possible to reduce information other than the running road, which is effective for simplification of the display of a road form. Further, in the case where the user's vehicle is running on a highway or an access road connecting with a parking area or an interchange from the highway, the running road selecting unit **341** operates to select the highway under running and the access road connecting with the highway from the road data. Thereby, any road other than the above-mentioned road information is neither selected nor displayed at the time of running on the highway or the access road, which is effective for simplification of the display of a road form. Further, in the case where route induction is set, a road along an inducting road is selected. With the above processing, only information of the form of a road under running is selected. Therefore, the running road form becomes obvious at a glance, as shown in FIG. **17**, thereby improving the driver's understandability. Now consider that the case where roads around the user's vehicle and background information are all displayed without using the above-mentioned running road selecting unit. In this case, if the user's vehicle is moving at a high speed, a display image as shown in FIG. **16** assumes a moving picture since the positions of roads perpendicularly intersecting with the running road have a large change. This results in the elongation of a time until the understanding by the user and hence the deterioration of safety. On the other hand, with the use of the above-mentioned running road selecting unit, the display is restricted to only the road under running of the user's vehicle, as shown in FIG. **17**. In this case, the display image assumes display close to a still picture, thereby improving the safety. There is a possibility that the position of the user's vehicle cannot be specified in a fixed time after the navigation device starts its operation. In such a case, the running road selecting unit **341** operates to generate a virtual straight road which has a predetermined road width. At this time, there may be the case where the form of the generated road is different from the actual road form. At any time, however, the running road selecting unit **341** operates so that road form information is outputted. Therefore, it is possible to eliminate a state in which a road form cannot be displayed.

A map attribute selecting unit **342** operates to select information which is to be displayed in a superimposed manner in addition to the running road of the user's vehicle selected by the running road selecting unit **341**. The map attribute selecting unit **342** has a function of selecting background information such as water systems and green zones, character information such as place names, and marks or deform symbols such as public services and amusement places in accordance with the running condition of the user's vehicle and the operating condition of the navigation device. The detailed operation of the map attribute selecting unit **342** will be described later on.

A road form generating unit **343** generates a road form on the basis of road data selected by the running road selecting unit **341** and the map attribute selecting unit **342**. A format of map data used for generating the road form is broadly classified into first data or road data which is formed by node information and link information when a road is represented by one vector data along the center of that road, and second data or residential area map data which includes a road outline form stored with node information. When one road is represented, a straight line connecting nodes assumes one broken line in the case of road data and two broken lines in the case of residential area map data.

Next, a method of generating a road form from the road data will be described using FIG. **18**. Since an actual road has a width, it is necessary to generate right and left road outlines **2012** and **2011** from one broken line **2010** which connects nodes. Herein, in the case where width information or the like concerning a road under running does not exist in a storage medium of the map memory **203**, outlines corresponding to a road width obtained as the result of imaging of the road by the image pickup device **102** are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined road width. Also, in the case where only road type information of the road under running exists in the storage medium of the map memory **203**, outlines having a predetermined road width corresponding to the road type of the running road are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined road width. Further, in the case where the width of the running road is stored in the storage medium of the map memory **203**, outlines having a road width corresponding to the width of the running road are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined road width. Thereby, it is possible to generate a road form conformable to the actual form. Also, in the case where the number of lanes of the running road is stored in the storage medium of the map memory **203**, outlines having a road width corresponding to the number of lanes are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined number of lanes. Thereby, it is possible to generate a road form conformable to the actual form. Further, outlines representing the lanes may be generated.

Next, a method of generating a road form from the residential area map data will be described. The residential area map data is formed beforehand by form information of road outlines as shown in FIG. **16**. Therefore, if only a road under running is selected, there results in that disconnections **2013** and **2014** as shown in FIG. **19** are generated. Accordingly, a straight line connecting the front and rear ends of the disconnection is generated, thereby enabling the generation of a road form as shown in FIG. **17**.

A map representation judging unit **344** judges which representing manner should road information or the like generated the road form generating unit **343** be displayed on the display unit in. In the case where the user makes a request for plane view representation, that is, representation equivalent to a paper map, the map representation judging unit **344** requests a plane map developing unit **345** to effect display in plane view representation. On the other hand, in the case where the user makes a request for birds-eye view representation, the map representation judging unit **344** sets a point-of-sight position to a rear position from which the present position of the user's vehicle is overlooked and requests an artificial three-dimensional map developing unit **346** to effect display in birds-eye view representation.

The plane map developing unit **345** and the artificial three-dimensional map developing unit **346** make the coordinate conversion of map data or vector data representative of form information of road outlines so that in the case of plane map representation, the position of the user's vehicle is located at a predetermined position on the display unit at a predetermined scale and the progressing azimuth of the user's vehicle assumes an upward direction on the display unit and so that in the case of an artificial three-dimensional map or a three-dimensional map, the position of the user's vehicle and the position of a peripheral vehicle are overlooked at a predetermined scale from a given point-of-sight position. Further, the plane map developing unit **345** or the artificial three-dimensional map developing unit **346** uses the coordinate-converted vector data to generate a command drawing a series of lines representing the road outlines and transfers the graphics drawing command to the graphics processing block **251** to effect the drawing so that a plane view or birds-eye view is displayed on the display unit **115**.

A vehicle information generating unit **347** make the coordinate conversion of the position of the user's vehicle obtained by the map matching block **247** and the position of a preceding vehicle and the position of a peripheral vehicle obtained by the other vehicle position determining block **249** in a manner similar to the above-mentioned coordinate conversion, generates a command for drawing marks indicative of the positions of those vehicles and transfers the graphics drawing command to the graphics processing block **251** to effect the drawing so that the position of the user's vehicle, the position of the preceding vehicle and the position of the peripheral vehicle are displayed on the display unit **115** in a manner superimposed on the plane view or birds-eye view. An example of display of vehicle information superimposed on a plane view is shown FIG. **17**, and an example of display of vehicle information superimposed on a birds-eye view is shown FIG. **22**. It is preferable that the vehicle information generating unit **347** judges the display/non-display of vehicle position information in accordance with the scale of a road to be displayed and makes the switching of display/non-display on the basis of the result of judgement. Namely, the vehicle information generating unit **347** operates to display vehicle information when the scale is smaller than a predetermined scale (for example, 1/2500 or 1/5000 with which a town map can be displayed) and to display no vehicle information when it is larger than the predetermined scale. Thereby, since the vehicle information generating unit **347** operates so that vehicle position information is not generated when the reduction is made up to an extension in which the vehicle information cannot be discriminated even if it is displayed, a processing load becomes small.

FIG. **14** is a diagram for explaining a second example of the functional construction of the other vehicle position displaying block **250**. Each constituent elements will now be described.

A non-running road deleting unit **361** operates, in connection with map information read by the data reading block **248** from the map information storage medium, to delete unnecessary road data from the read road information. More particularly, the non-running road deleting unit **361** operates to delete roads other than a road under running of the user's vehicle and a road of a road type the deletion of which is inhibited by a map information deletion stopping unit **364**. In substance, the road under running of the user's vehicle herein referred to indicates data of a road of the same type as a road link under running. Also, in the case where the same type of road forks into three or more branches at the same node, road data matching in road name (such as 1st national road, 25th prefectural road or Miura highway) with the road under running is indicated. Further, a road near to straight advance in similar branches may be indicated. Also, in the case where the user's vehicle is running on a highway or an access road connecting with a parking area or an interchange from the highway, the highway under running and the access road connecting with the highway are indicated. With this processing, there results in that only information of the form of a road under running of the user's vehicle is displayed, as shown in FIG. **17**. Therefore, the running road form becomes obvious at a glance, thereby improving the understandability. Further, the display image assumes display close to a still picture, thereby improving the safety. There is a possibility that the position of the user's vehicle cannot be specified in a fixed time after the navigation device starts its operation. In such a case, the non-running road deleting unit **361** operates to generate a virtual straight road which has a predetermined road width. At this time, there may be generated the case where the form of the generated road is different from the actual road form. At any time, however, the non-running road deleting unit **361** operates so that road form information is outputted. Therefore, it is possible to eliminate a state in which a road form cannot be displayed.

A character/symbol information deleting unit **362** operates, in connection with map information read by the data reading block **248** from the map information storage medium, so that character/symbol information other than character/symbol information the deletion of which is inhibited by the map information deletion stopping unit **364** is deleted from character information such as place names, map symbols representative of public services, deform symbols representative of restaurants and convenience stores, and so forth. The map information deletion stopping unit **364** designates, character/symbol information to be subjected to the inhibition of deletion, by virtue of the attribute, type, individual identification number and/or the like of a character/symbol. Further, the attribute, type, individual identification number and/or the like of a character/symbol to be subjected to the inhibition of deletion can be designated doubly. For example, when restaurants and place names are to be subjected to the inhibition of deletion, character/symbol information other than restaurants and place names is deleted and there results in that deform symbols representative of restaurants and character strings of place names are displayed in a manner superimposed on the map. As a result, the representation on the display screen becomes simple, thereby improving the understandability.

A background information deleting unit **363** operates, in connection with map information read by the data reading block **248** from the map information storage medium, so that background information other than background information the deletion of which is inhibited by the map information deletion stopping unit **364** is deleted from information which

is to be displayed in a manner superimposed on a map in addition to road information and character/symbol information, that is, from background information which includes water system information such as rivers, lakes and seas, railway information, urban district information, greens information, and so forth. The map information deletion stopping unit **364** designates, background information to be subjected to the inhibition of deletion, by virtue of the attribute, type, individual identification number and/or the like of a background. Further, the attribute, type, individual identification number and/or the like of a background to be subjected to the inhibition of deletion can be designated doubly. For example, when water systems and railways are to be subjected to the inhibition of deletion, background information other than water systems and rail ways is deleted and there results in that broken lines and planes representative of water systems and broken lines representative of railways are displayed in a manner superimposed on the map. As a result, the representation on the display screen becomes simple, thereby improving the understandability.

In the case where the stop detecting unit **304** judges the speed of the user's vehicle as being lower than the predetermined speed, the map information deletion stopping unit **364** controls the non-running road deleting unit **361**, the character/symbol information deleting unit **362** and the background information deleting unit **363** so that map attributes and road types corresponding to the running speed are not subjected to non-display. With this processing, it becomes possible to display an increased amount of map information as the speed is lowered. Further, the map information deletion stopping unit **364** controls the non-running road deleting unit **361**, the character/symbol information deleting unit **362** and the background information deleting unit **363** so that map attributes designated by the user and analyzed by the user operation analyzing block **241** are not subjected to nondisplay.

A road form generating unit **365** generates a road form other than road data deleted by the non-running road deleting unit **361**. A format of map data used for generating the road form is broadly classified into first data or road data which is formed by node information and link information when a road is represented by one vector data along the center of that road, and second data or residential area map data which includes a road outline form stored with node information. Accordingly, when one road is represented, a straight line connecting nodes assumes one broken line in the case of road data and two broken lines in the case of residential area map data.

First, a method of generating a road form from the road data will be described using FIG. **18**. Since an actual road has a width, it is necessary to generate right and left road outlines **2012** and **2011** from one broken line **2010** which connects nodes. Herein, in the case where width information or the like concerning a road under running does not exist in a storage medium of the map memory **203**, outlines corresponding to a road width obtained as the result of imaging of the road by the image pickup device **102** are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined road width. Also, in the case where only road type information of the road under running exists in the storage medium of the map memory **203**, outlines having a predetermined road width corresponding to the selected road type are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined road width. Further, in the case where the width of the running road is stored in the storage medium of the map memory **203**, outlines having a road width corresponding to the width of the running road are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined road width. Thereby, it is possible to generate a road form conformable to the actual form. Also, in the case where the number of lanes of the running road is stored in the storage medium of the map memory **203**, outlines having a road width corresponding to the number of lanes are generated by generating broken lines through the parallel movement of the road form forming broken line **2010** in directions perpendicular to the broken line **2010** by a quantity corresponding to a predetermined number of lanes. Thereby, it is possible to generate a road form conformable to the actual form. Further, outlines representing the lanes may be generated.

Next, a method of generating a road form from the residential area map data will be described. The residential area map data is formed beforehand by form information of road outlines as shown in FIG. **16**. Therefore, if only a road under running is selected, there results in that disconnections **2013** and **2014** as shown in FIG. **19** are generated. Accordingly, a straight line connecting the front and rear ends of the disconnection is generated, thereby enabling the generation of a road form as shown in FIG. **17**.

A map representation judging unit **366** judges which representing manner should road information or the like generated the road form generating unit **365** be displayed on the display unit in. In the case where the user makes a request for plane view representation, that is, representation equivalent to a paper map, the map representation judging unit **366** requests a plane map developing unit **367** to effect display in plane view representation. On the other hand, in the case where the user makes a request for birds-eye view representation, the map representation judging unit **366** sets a point-of-sight position to a rear position from which the present position of the user's vehicle is overlooked and requests an artificial three-dimensional map developing unit **368** to effect display in birds-eye view representation.

The plane map developing unit **367** and the artificial three-dimensional map developing unit **368** make the coordinate conversion of map data or vector data representative of form information of road outlines so that in the case of plane map representation, the position of the user's vehicle is located at a predetermined position on the display unit at a predetermined scale and the progressing azimuth of the user's vehicle assumes an upward direction on the display unit and so that in the case of an artificial three-dimensional map or a three-dimensional map, the position of the user's vehicle and the position of a peripheral vehicle are overlooked at a predetermined scale from a given point-of-sight position. Further, the plane map developing unit **367** or the artificial three-dimensional map developing unit **368** uses the coordinate-converted vector data to generate a command drawing a series of lines representing the road outlines and transfers the graphics drawing command to the graphics processing block **251** to effect the drawing so that a plane view or birds-eye view is displayed on the display unit **115**.

A vehicle information generating unit **369** make the coordinate conversion of the position of the user's vehicle obtained by the map matching block **247** and the position of a preceding vehicle and the position of a peripheral vehicle

obtained by the other vehicle position determining block **249** in a manner similar to the above-mentioned coordinate conversion, generates a command for drawing marks indicative of the positions of those vehicles and transfers the graphics drawing command to the graphics processing block **251** to effect the drawing so that the position of the user's vehicle, the position of the preceding vehicle and the position of the peripheral vehicle are displayed on the display unit **115** in a manner superimposed on the plane view or birds-eye view. An example of display of vehicle information superimposed on a plane view is shown FIG. **17**, and an example of display of vehicle information superimposed on a birds-eye view is shown FIG. **22**. It is preferable that the vehicle information generating unit **369** judges the display/non-display of vehicle position information in accordance with the scale of a road to be displayed and makes the switching of display/non-display on the basis of the result of judgement. Namely, the vehicle information generating unit **369** operates to display vehicle information when the scale is smaller than a predetermined scale and to display no vehicle information when it is larger than the predetermined scale. Thereby, since the vehicle information generating unit **369** operates so that vehicle position information is not generated when the reduction is made up to an extension in which the vehicle information cannot be discriminated even if it is displayed, a processing load becomes small.

FIG. **15** is a diagram for explaining the functional construction of the map attribute selecting unit **342**. Each constituent elements will now be described.

An induction information output judging unit **381** makes, when a route to a destination and a route inducing function is operating, the judgement of whether or not an induction screen is to be displayed on the other vehicle position displaying block **250**. The judgement is made on the basis of an induction information display timing signal sent from the induction diagram display instructing unit **326**. A method for judgement includes checking whether or not an induction crossing **2015** enters a judgement area **2016** which is positioned inwards from an outer frame of the display unit by the number of pixels corresponding to a predetermined width, as shown in FIG. **20**. In the case where the induction crossing enters the judgement area, the induction information output judging unit **381** operates to activate a route induction information selecting unit **382**.

The route induction information selecting unit **382** selects a road **2018** connecting with the induction crossing **2015** from map data and generates an inducing arrow **2017** on the basis of approach information and leave information for the induction crossing. Thereby, the running road and an inducing road connecting with the induction crossing are selected from roads (see FIG. **16**) around the user's vehicle and are displayed, as shown in FIG. **21**. Therefore, even while the form of the running road is being displayed, route induction is continuously effected. In connection with a road connecting with the induction crossing, if the same type of road adjacent to that road is selected, the amount of information can be limited efficiently, thereby improving the understandability of the display screen. Also, after the display of the induction crossing is started, it is preferable that a change is made from a displaying method the position of the user's vehicle is fixed at one certain point on the display unit to a displaying method in which the induction crossing **2015** is fixed at one certain point on the display unit. Thereby, the displaying position of road information is fixed on the display screen while only the displaying position of vehicle position information changes every moment due to the movement of the user's vehicle **2000** and the other peripheral vehicle **2001**. Therefore, the possibility of erroneous judgement of information of the induction crossing including of the position and form thereof becomes small. On the other hand, after the user's vehicle passes through the induction crossing, it is preferable to return to the displaying method the position of the user's vehicle is fixed at one certain point on the display unit. In a crossing, there is a possibility that the user's vehicle makes a large change in direction. Therefore, if the map is rotated, it is difficult to grasp the form of the crossing.

A running condition dependent attribute selecting unit **383** operates so that information to be displayed in addition to a road under running of the user's vehicle is selected in accordance with the running condition of the user's vehicle, that is, the speed, progressing direction and so forth of the user's vehicle. A speed dependent attribute selecting unit **384** for selecting information to be displayed in accordance with the speed of the user's vehicle will now be described as a typical example of the running condition dependent attribute selecting unit **383**. If information including roads intersecting a road under running of the user's vehicle, roundabout ways and so forth is displayed when the user's vehicle is running at a high speed, there results in the display of a large amount of information and this provides a cause for erroneous judgement. At the time of vehicle stop or at the time of low-speed running, however, the presentation of information of roads in the neighborhood of the user's vehicle and so forth to the user or driver is effective for the driver to acquire geographical information of the neighborhood and information of roundabout ways. Accordingly, the speed dependent attribute selecting unit **384** receives information outputted from the stop detecting unit **304** about whether or not the running speed of the user's vehicle is 0 km/h or lower than a predetermined speed, and operates, when the speed is 0 km/h, to select information of all roads inclusive of the running road, or to select main roads (that is, highways, national roads, prefectural roads, and so forth) or to select road attributes set by the user and analyzed by the user operation analyzing block **241**. In the case where the speed is lower than the predetermined speed (10 km/h or a speed regulated by the Motor Vehicle Industry Society), too, the speed dependent attribute selecting unit **384** performs an operation similar to that in the case where the speed is 0 km/h, that is, the speed dependent attribute selecting unit **384** selects information of all roads inclusive of the running road, selects road types corresponding to the vehicle speed or selects road attributes set by the user and analyzed by the user operation analyzing block **241**. Also, the speed dependent attribute selecting unit **384** may operate to select not only road information but also character/symbol information and/or background information so that various information is provided at the time of stop when the user can afford to see the display screen. Further, a method of selecting information to be displayed in accordance with the weather condition of the vicinity of a road under running of the user's vehicle and/or the brightness of the surroundings thereof will now be described as another embodiment of the running condition dependent attribute selecting unit **383**. For example, in the case where the visibility is poor owing to rainy weather, snowy weather or the like or in the case where the visibility is poor owing to night time or the like, the running condition dependent attribute selecting unit **383** operates to display a more amount of information in order to compensate for the poor visibility. Namely, at the time of poor visibility, the running condition dependent attribute selecting unit **383** operates so that in addition to road attributes, background information and character/symbol

information selected at the time of normal running, information of predetermined attributes is excluded from the inhibition of display. Thereby, even when the amount of information necessary for driving is reduced owing to the deterioration of visibility, map information is displayed on the display unit, thereby improving the understandability.

A display information selecting unit 385 operates to select map attributes a request for continual display of which is made by the user through the user operation analyzing block 241. An example of selected map attributes may include point information registered by the user, parking place information, gasoline stand information, and so forth.

Map information thus selected by the route induction dependent attribute selecting unit 383 and the display attribute selecting unit 385 is developed to a drawing command by the plane map developing unit 345 or the artificial three-dimensional map developing unit 346 so that the selected map information is displayed in a manner superimposed on a running road.

According to the present invention as described above, a road form is generated from a map database possessed by a navigation device. Therefore, a vehicle provided with the navigation device operates so that cruise control information is displayed at a low cost and accurately. Further, since it can be operated so that the display is limited to the form of a road under running of a user's vehicle, a simplified display screen is provided, thereby improving the understandability by the user. Also, since the simplified display screen shortens a time required for reading information, the contribution to the improvement in safety is made.

What is claimed is:

1. A vehicle position information displaying apparatus comprising:

map storing means for outputting map information of a predetermined area stored therein;

means for detecting a present position of a user's vehicle;

another vehicle detecting means for detecting a position of the another vehicle around a present position of a user's vehicle detected by said user's vehicle present position detecting means; and

displaying means for displaying the map information outputted from said map storing means, information of the detected present position of said user's vehicle, and information of the detected position of the another vehicle in a superimposed manner on a display screen.

2. A vehicle position information displaying apparatus according to claim 1, further comprising running road selecting means for selecting road information of a running road of the user's vehicle from said map information on the basis of the present position of the user's vehicle so that the selected road information is outputted.

3. A vehicle position information displaying apparatus according to claim 2, further comprising speed detecting means for detecting the running speed of the user's vehicle, and map information deletion stopping means for stopping the operation of at least one of said running road selecting means, said non-running road deleting means, said character/symbol information deleting means and said background information deleting means when the detected running speed of the user's vehicle is lower than a predetermined speed.

4. A vehicle position information displaying apparatus according to claim 2, further comprising virtual road generating means for outputting information of a virtual straight road having a predetermined road width when it is determined that the present position of the user's vehicle is not detected.

5. A vehicle position information displaying apparatus according to claim 2, further comprising route determining means for determining a route to a destination, route inducing means for presenting the route to the destination to a user by virtue of at least one of voice and display, and route induction information selecting means for selecting information concerning said route from said map information so that the selected information is outputted.

6. A vehicle position information displaying apparatus according to claim 1, further comprising non-running road deleting means for deleting information of roads other than a running road of the user's vehicle from said map information on the basis of the present position of the user's vehicle so that the map information subjected to deletion is outputted.

7. A vehicle position information displaying apparatus according to claim 1, further comprising character/symbol information deleting means for deleting name information inclusive of place names and symbol information from said map information so that the map information subjected to deletion is outputted.

8. A vehicle position information displaying apparatus according to claim 1, further comprising background information deleting means for deleting background information inclusive of water systems and green zones other than roads from said map information so that the map information subjected to deletion is outputted.

9. A vehicle position information displaying apparatus according to claim 1, wherein said displaying means includes means for judging whether or not the information concerning the other vehicle should be displayed, the judgement being made on the basis of a map scale of the inputted map information.

10. A vehicle position information displaying apparatus according to claim 1, further comprising driving mechanism control means for controlling a driving mechanism of the user's vehicle so that the user's vehicle runs in a state in which an inter-vehicle distance between the user's vehicle and a target vehicle for follow-up is maintained at a set value, and activating means for activating said displaying means when said driving mechanism control means starts its operation.

11. A vehicle position information displaying apparatus according to claim 1, further comprising running condition dependent attribute selecting means for selecting information of a predetermined attribute from said map information in accordance with the running condition of the user's vehicle so that the selected attribute information is outputted.

12. A vehicle position information displaying apparatus according to claim 11, further comprising highway running judging means for judging whether or not the user's vehicle is running on a highway or an access road to the highway, said running condition dependent attribute selecting means selecting the highway or the access road to the highway when said highway running judging means determines that the user's vehicle is running on the highway.

13. A vehicle position information displaying apparatus according to claim 1, wherein said running condition dependent attribute selecting means selects the attribute in accordance with the detected speed of the user's vehicle.

14. A vehicle position information displaying method comprising the steps of:

detecting a present position of a user's vehicle

outputting map information of a predetermined area stored including the detected present position;

detecting the position of another vehicle around the detected present position of the user's vehicle; and

displaying the outputted map information, the detected present position of the user's vehicle and the detected position of the another vehicle in a superimposed manner on a display screen.

15. A vehicle position information displaying apparatus comprising:

map memory configured to output map information of a predetermined area stored therein;

a first detector apparatus configured to detect a user vehicle's present position;

a second detector apparatus configured to detect a position of another vehicle around the detected present position of the user's vehicle and to output information of the another vehicle's detected position; and

a display configured to superimpose the map information, and information related to the user's vehicle present position and of the another vehicle's detected position on a display device.

16. A vehicle position information displaying apparatus according to claim 15, further comprising a selector configured to select road information of a running road of the user's vehicle from said map information on the basis of the user's vehicle present position and to output the selected road information.

17. A vehicle position information displaying apparatus o according to claim 16, further comprising a detector configured to detect a running speed of the user's vehicle, and a deletion stopper configured to stop operation of at least one of said running road selector, said non-running road deleter, said character/symbol information deleter and said background information deleter at a point where detected running speed of the user's vehicle is below a predetermined speed.

18. A vehicle position information displaying apparatus according to claim 16, further comprising a generator configured to output information of a virtual straight road having a predetermined road width upon a determination that the present position of the user's vehicle is not detected.

19. A vehicle position information displaying apparatus according to claim 16, further comprising a determinator device configured to determine a route to a destination, an inducer device configured to present the route to the destination to a user by at least one of voice and visual display, and a route induction information selector configured to select information concerning said route from said map information and to output the selected information.

20. A vehicle position information displaying apparatus according to claim 15, further comprising a deleter configured to delete information of roads other than a running road of the user's vehicle from said map information on the basis of the user's vehicle present position and to delete the map information subjected to deletion.

21. A vehicle position information displaying apparatus according to claim 15, further comprising a deleter configured to delete name information inclusive of place names and symbol information from said map information and to output the map information subjected to deletion.

22. A vehicle position information displaying apparatus according to claim 15, further comprising a deleter configured to delete background information inclusive of water systems and green zones other than roads from said map information and to output the map information subjected to deletion.

23. A vehicle position information displaying apparatus according to claim 15, wherein said display is configured to judge whether or not the information concerning the another vehicle should be displayed on the basis of a map scale of the map information.

24. A vehicle position information displaying apparatus according to claim 15, further comprising a controller configured to control a driving mechanism of the user's vehicle so that the user's vehicle runs in a state in which an inter-vehicle distance between the user's vehicle and a target vehicle for follow-up is maintained at a set value, and the display being configeed to be activated at start of operation of said controller.

25. A vehicle position information displaying apparatus according to claim 15, further comprising a running condition dependent attribute selector configured to select information of a predetermined attribute from said map information in accordance with the running condition of the user's vehicle and to output the selected attribute information.

26. A vehicle position information displaying apparatus according to claim 25, wherein said running condition dependent attribute selector is configured to select the attribute in accordance with a detected speed of the user's vehicle.

27. A vehicle position information displaying apparatus according to claim 25, further comprising a highway running judgment mechanism configured to judge if the user's vehicle is running on a highway or an access road to the highway, and said running condition dependent attribute selector being configured to select the highway or the access road to the highway when said highway running judgment mechanism determines that the user's vehicle is running on the highway.

* * * * *

US005497271A

United States Patent [19]

Mulvanny et al.

[11] **Patent Number: 5,497,271**

[45] **Date of Patent: Mar. 5, 1996**

[54] **HEAD UP DISPLAYS FOR MOTOR VEHICLES**

[75] Inventors: **Paul Mulvanny**, Braunston; **Malcolm Williams**, Crescent, both of United Kingdom

[73] Assignee: **Jaguar Cars Limited**, Allesley, England

[21] Appl. No.: **285,022**

[22] Filed: **Aug. 2, 1994**

[30] **Foreign Application Priority Data**

Sep. 7, 1993 [GB] United Kingdom 9318520

[51] **Int. Cl.**^{6} **G02B 27/14**; G09G 5/00

[52] **U.S. Cl.** **359/631**; 359/630; 359/634; 345/7

[58] **Field of Search** 359/630, 631, 359/13, 632, 633, 838; 345/7, 9; 348/115

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,603,929	9/1971	Drysdale	359/630
3,885,095	5/1975	Wolfson	359/630
3,915,548	10/1975	Opittek	359/15
4,697,879	10/1987	Gerbe	345/7
4,737,001	4/1988	Moss	359/34
4,987,410	1/1995	Berman	340/705
5,037,182	8/1991	Groves	359/630
5,129,309	7/1992	Lecuyer	89/41.06
5,140,465	8/1992	Yasui	359/631

FOREIGN PATENT DOCUMENTS

0326323	8/1989	European Pat. Off. .
0420196	4/1991	European Pat. Off. .
2847590	5/1980	Germany .
9201038	4/1992	Germany .
58-080616	5/1983	Japan .
1409743	10/1975	United Kingdom .
8706017	10/1987	WIPO .

OTHER PUBLICATIONS

Chip, No. 6, Jun. 1990, Wurzburg, Germany, pp. 20–24, XP125797.

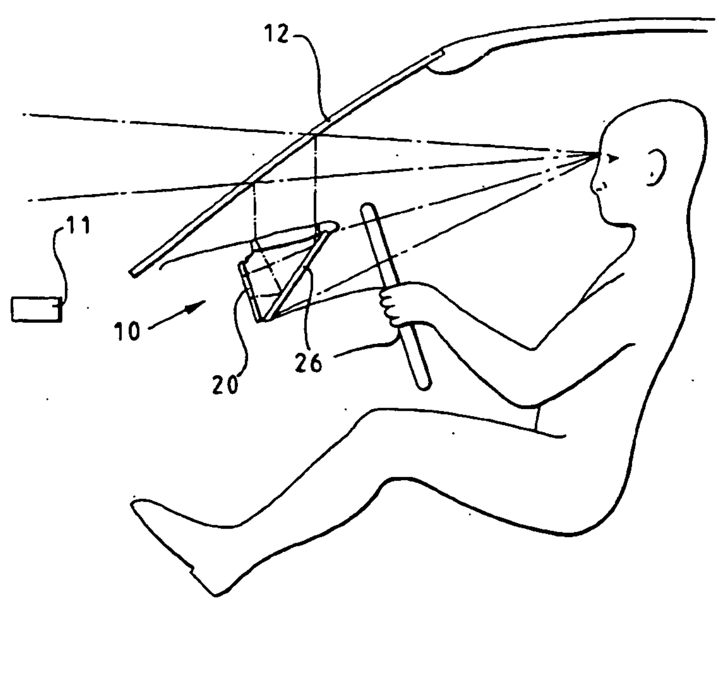
Rainer Grabowski 'Head-up display, Bilder und texte schweben wie eine Fata Morgana im Raum erzeugt von Head-up Displays, dijetzt Einzug in die Alltagswelt halten. Es liegt was in der lugt', p. 23, paragraph 2-paragraph 3 and p. 24, col. 3, paragraph 2.

Primary Examiner—Georgia Y. Epps
Assistant Examiner—Ricky Mock
Attorney, Agent, or Firm—Davis, Bujold & Streck

[57] **ABSTRACT**

A head up display system for a motor vehicle includes a sensor, display means for forming a video image from the signals received from the sensor and a projection system for projecting the video image onto the windscreen of the vehicle, the projection system including a mirror for deflecting the optical path of the projected image, said mirror being located directly in front of a driver of the vehicle at a level outside the normal field of view of the driver through the windscreen, the mirror being arranged; in a head up display mode, to direct the projected image onto the windscreen; and in a non-head up display mode, to permit direct viewing of the video image at a level outside the normal field of view of the driver through the windscreen.

14 Claims, 2 Drawing Sheets



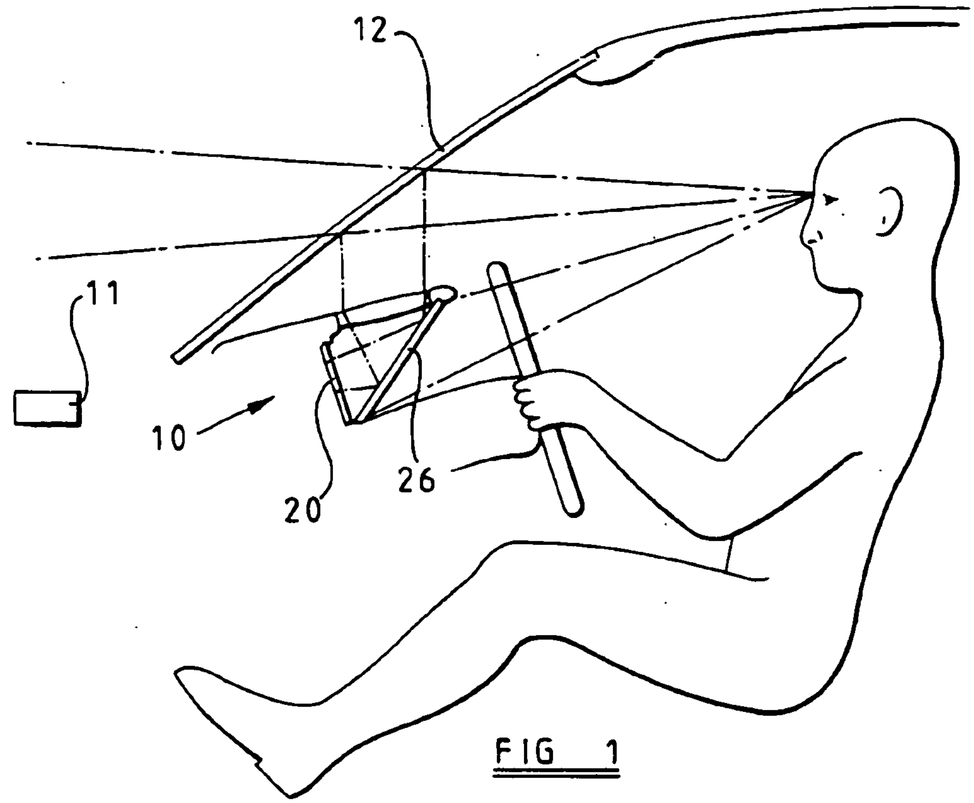


FIG 1

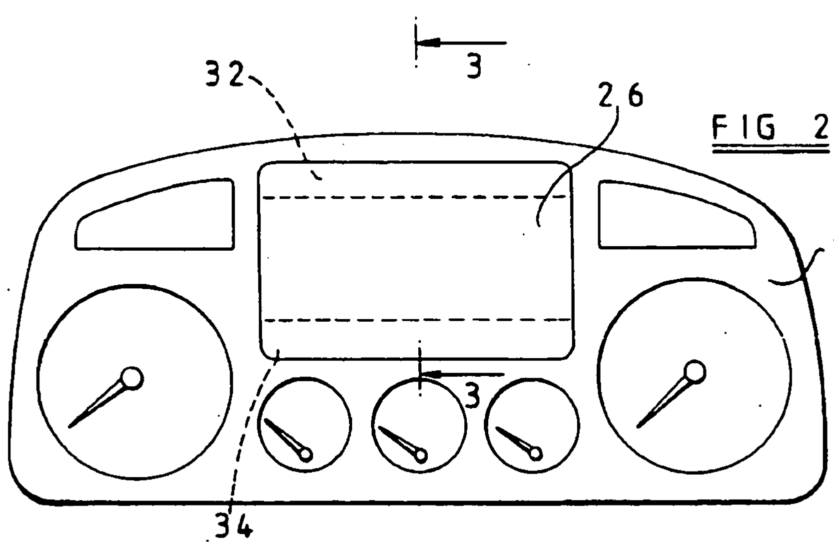


FIG 2

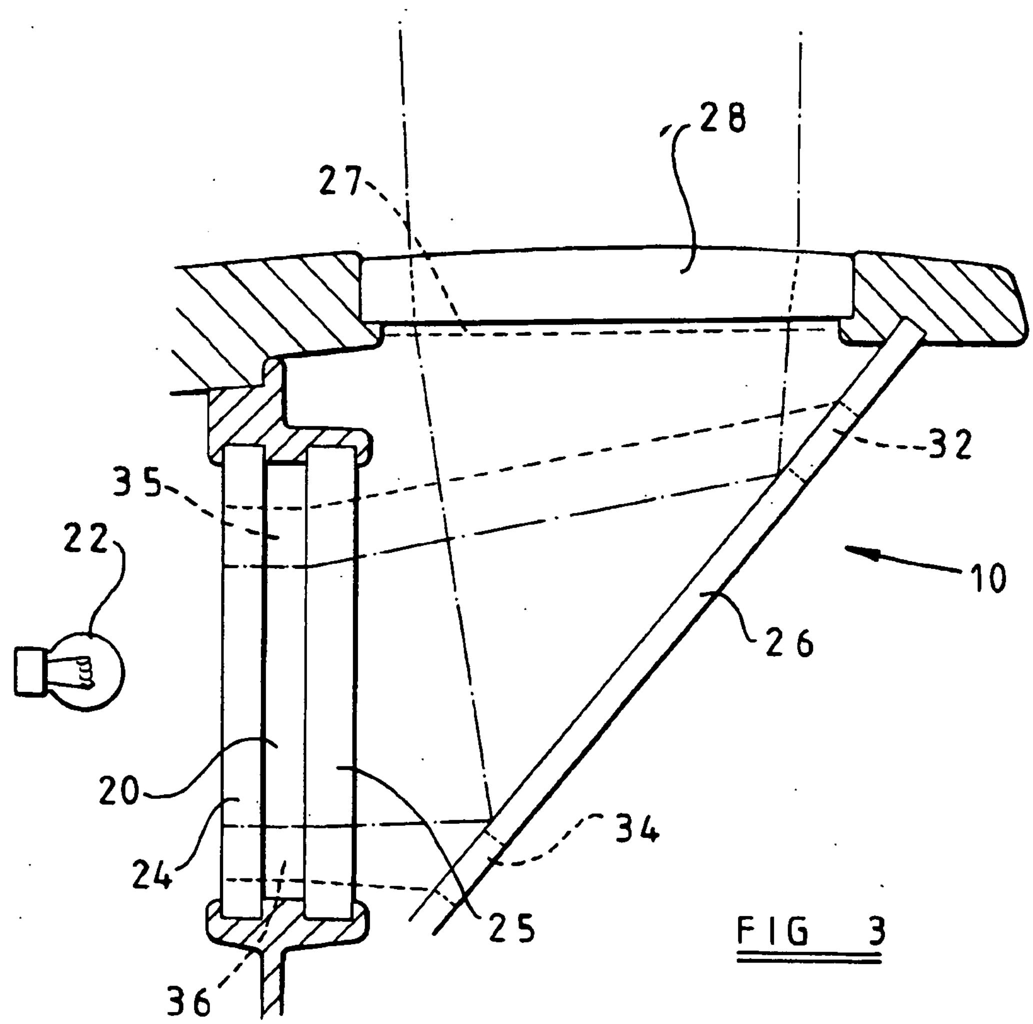


FIG 3

HEAD UP DISPLAYS FOR MOTOR VEHICLES

BACKGROUND TO THE INVENTION

The present invention relates to head up displays for motor vehicles.

It has been proposed to provide a head up display for a motor vehicle in which an enhanced view of the road ahead is projected onto the vehicle windscreen, so that it is overlaid onto the drivers view of the scene. In this manner, potential hazards which may not be clearly visible to the driver, may be highlighted.

In order to ensure that the objects within the image appear to the driver to be the same size as the objects in the real scene, the field of view of the sensor is matched to the field of view which the driver has of the display. The image is then projected into the relevant area of the driver's forward line of sight and is arranged such that the driver's own view of the objects is overlaid with the images of the objects generated from the sensor, processing and display combinations.

To produce an overlaid image of this type, a large field of view is required. Within the constraints of the motor vehicle which places limitations on the size of the video display device which may be used and the optical path length of the projected image, this may be achieved by the use of a mirror which will bend the optical path. This will also allow the display device to be positioned behind the dashboard of a vehicle, the mirror serving to deflect the projected image onto the windscreen.

The centre line of the projected image and the centre line of the driver's forward field of view must also be coincident. As a result, the mirror used to deflect the projected image onto the windscreen must be positioned directly in front of the driver at a level below the level of the windscreen. That is, in a position conventionally used for the vehicle instrument display. The positioning of a mirror in this way will consequently significantly reduce the area available for vehicle instrument display.

SUMMARY OF THE INVENTION

According to one aspect of the present invention a head up display system for a motor vehicle comprises sensor means, means for forming a video image from the signals received from the sensor means and means for projecting the video image onto the windscreen of the vehicle, said means for projecting the video image including a mirror for deflecting the optical path of the projected image, said mirror being located directly in front of the driver at a level outside the normal field of view of the driver through the windscreen; the mirror being adapted, in a head up display mode, to permit projection of the image onto the windscreen; and, in a non-head up display mode, to permit viewing of the projected image at a level outside the normal field of view of the driver through the windscreen.

In accordance with the above described invention, when in the head up display mode the system will project the projected image onto the windscreen. However, in a non-head up display mode, the means for forming a video image may be used to provide a flexible format display which may form part of the conventional instrument display of the vehicle. This flexible format display may be used, for example, to display operating parameters of the vehicle, navigational information and/or views to the rear or sides of the vehicle for manoeuvring purposes.

Preferably the mirror reflects the projected image onto the windscreen in the head up display mode and permits passage of the projected image so that it may be viewed directly in the non-head up display mode. The mirror is furthermore preferably located at a level below that of the windscreen.

According to one embodiment of the invention, the mirror is a narrow band reflector, so that only light in a narrow waveband is reflected onto the windscreen. This form of mirror may be used with a light source emitting light within the narrow band, when in the head up display mode and a second light source emitting light outside the narrow band when in the non-head up display mode. However, preferably wide band light source is used in both modes, shutter means being provided to intercept the reflected light when in the non-head up display mode.

Alternatively, the mirror may be switchable electronically, by for example the use of electrochromic coatings or solutions; or may be movable mechanically between a position in which it is disposed in the path of the projected image and reflects the image onto the windscreen; and a position in which it is clear of the path of the projected image. Such systems may be used to project full colour or limited waveband images onto the windscreen.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention is now described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is a partial sectional elevation of a motor vehicle with head-up display in accordance with the present invention;

FIG. 2 is a plan view of an instrument panel of a vehicle fitted with a head-up display in accordance with the present invention; and

FIG. 3 is a sectional elevation of the head-up display system used in the vehicle illustrated in FIG. 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

As illustrated in FIG. 1, the head up display system **10** of the present invention projects an image onto the windscreen **12** of the vehicle, which coincides with the driver's view of the scene ahead of the vehicle. The head up display is arranged such that images produced by the head up display system are overlaid onto the objects viewed directly by the driver.

As illustrated in greater detail in FIGS. **2** and **3**, the head up display system **10** includes a mirror **26** which reflects a projected image onto the windscreen **12**. The mirror **26** is adapted to permit the passage of a projected image when the head up display system is not on, to provide a flexible format display which may be viewed in a head down display mode.

As illustrated in FIGS. **2** and **3**, the head up display system **10** comprises a liquid crystal display **20** which converts signals from a sensor **11** which looks forwardly of the vehicle, into a video image. The sensor may operate in the infra-red, visible and/or ultra-violet wavelengths and the signals therefrom are processed to enhance the image.

The liquid crystal display **20** is illuminated by a wide band light source **22** and a lens system **24, 25** projects the video image produced by the liquid crystal display **20** onto a narrow waveband mirror **26**, which is located centrally of

the vehicle instrument panel 30 as illustrated in FIG. 2. The mirror 26 reflects light within the narrow waveband upwardly through an exit lens 28 and onto the windscreen 12. Light of wavelength outside the narrow waveband of mirror 26 is transmitted through the mirror 26 to provide a flexible format display which may be viewed on the reverse side of the mirror 26.

In the head up display mode of operation, the video image produced by the liquid crystal display 20 is reflected onto the windscreen 12 by mirror 26, so that it may be viewed by the driver. A display of reduced colour range of the image is also transmitted through the mirror 26 and may be viewed by the driver in a head down display mode.

When the head up display is switched off, a shutter 27 is placed over the exit lens 28, so that no image is projected onto the windscreen 12. The shutter 27 also prevents reflections from the optical system of the head up display system which would otherwise be reflected onto the windscreen 12. The shutter 27 may, for example, be a layer or solution of electrochromic material controlled electronically, or may be a mechanically controlled shutter.

When the shutter 27 is closed, the liquid crystal display 20 may be used in a flexible format display mode, to provide a reduced colour range display on the reverse side of the mirror 26 which may be viewed in a head down display mode. This flexible format display may be used to display vehicle parameters and symbols, navigational information or other similar data.

In the embodiment illustrated above, only the central part of the mirror 26 need be used for head up display purposes. The top and bottom regions 32 and 34 may for example be arranged to transmit light over the full visible spectrum and the corresponding regions 35, 36 of the liquid crystal display 20 may give a permanent display of vehicle parameters or symbols which will be displayed in the full colour range, on the reverse side of the mirror 26, whether the head up display is functional or not. Such information may be in the form of an array of warning lights corresponding to various parameters of the vehicle.

The liquid crystal display 20 may furthermore be used to superimpose warning messages on the windscreen when in the head up display mode. Such messages should not however unduly distract the drivers attention from the road. This mode of operation of the system may be used, for example, to give warning of failure of vital systems of the vehicle, collision avoidance information or indications for turning the vehicle generated by navigational systems.

Various modifications may be made without departing from the invention. For example, while in the above embodiment the video image is produced by a liquid crystal display, other display devices which will create an image which may be projected for example, cathode ray tubes, ferromagnetic displays or plasma displays, may be used. Furthermore, in place of a narrow waveband mirror, an electronically controlled electrochromic mirror or mechanically moved mirror may be used.

We claim:

1. A head up display system for a motor vehicle comprising:

sensor means for determining objects ahead of the vehicle;

means for forming a video image of the objects ahead of the vehicle from the signals received from the sensor means, said means producing a first video image of light wavelengths within a first band of wavelengths

and for generating a second video image of light of wavelengths outside the first band of wavelengths;

means for projecting the first and second video images onto a selectively reflective mirror, said mirror being located between the video image generating means and a driver of the vehicle and directly in front of the driver at a level outside the normal field of view of the driver through the vehicle windscreen, the mirror reflecting light of wavelengths within said first band of wavelengths and transmitting light of wavelengths outside said first band of wavelengths;

the mirror reflecting the first video image of the objects ahead of the vehicle onto the vehicle windscreen where it is viewable by the driver of the vehicle, in a head up display mode; and

the second video image being transmitted through the mirror where it is viewable directly by the driver of the vehicle in a head down display mode.

2. A head up display system according to claim 1 in which the image of the objects ahead of the vehicle, projected onto the windscreen overlays the actual objects as viewed by the driver of the vehicle.

3. A head up display system according to claim 1 in which the mirror is located at a level below the level of the windscreen.

4. A head up display system according to claim 1 in which the means for projecting the video image includes a light source of wavelengths greater than the first band of wavelengths, light of wavelengths corresponding to the first band of wavelengths being reflected onto the windscreen while light of wavelengths outside that of the first band of wavelengths being transmitted through the mirror.

5. A head up display system according to claim 4 in which shutter means is provided, to be located between the mirror and windscreen to intercept the projected image, when the head up display is switched off.

6. A head up display system according to claim 5 in which the shutter is provided by an electronically controlled electrochromic layer or solution.

7. A head up display system according to claim 5 in which a mechanical shutter is moved into the path of the projected image when the head up display system is switched off.

8. A head up display system according to claim 1 in which, in the head up display system mode, the projected image is produced by a light source of wavelength within said first band of wavelengths.

9. A head up display system according to claim 1 in which the means for generating a second video image may be used to produce display, to be viewed at a level outside the normal field of view of the driver through the windscreen, in the head down display mode.

10. A head up display system according to claim 9 in which the display provides a display of vehicle parameters and symbols, navigational information and/or views to the rear or sides of the vehicle for manoeuvring purposes.

11. A head up display system according to claim 1 in which the device for forming a video image is one of a liquid crystal display, cathode ray tube, ferromagnetic display and plasma display.

12. A head up display system according to claim 1 in which the mirror is arranged to permit passage of a portion of the projected image whether the head up display system is functional or not, the means for forming the video image being used to produce a permanent flexible format display corresponding to said portion of the projected image.

13. A head up display system according to claim 9 in which the flexible format display provides a display of vehicle parameters and symbols, navigational information and/or views to the rear or sides of the vehicle for manoeuvering purposes.

14. A head up display system according to claim 1 in which the means for forming a video image is arranged to superimpose warning messages on the windscreen, when the system is in the head up display mode.

* * * * *